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GERMANISCHER LLOYD
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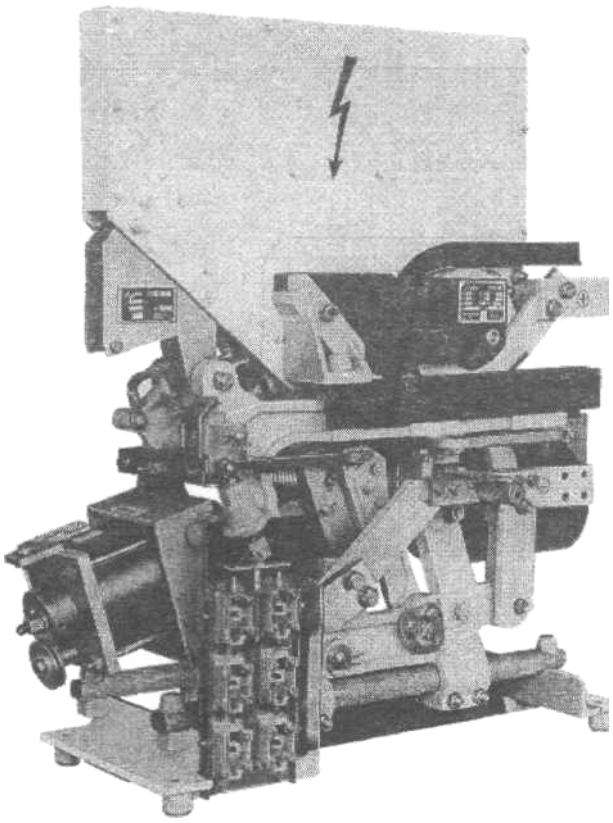
NOWA Apena ®

HIGH SPEED CIRCUIT BREAKERS
BWS



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CONTENTS

1. SAFETY CONSIDERATIONS 3
2. APPLICATION 4
3. CHARACTERISTICS 4
4. TECHNICAL DATA 5
5. CONSTRUCTION (FIG. 6-19) 8
6. PRINCIPLE OF OPERATION (FIG. 19) 10
6.1. Closing circuit-breakers with electromagnetic drive 10
6.2. Closing circuit-breakers with electro-pneumatic drive 11
6.3. Closing circuit-breakers with hand lever 11
6.4. Tripping-out 11
6.5. Intentional opening 11
6.6. Circuit-breaker control using control board 12
7. CIRCUIT-BREAKER INSTALLATION 14
8. CIRCUIT-BREAKER MAINTENANCE 14
9. CIRCUIT-BREAKER ADJUSTMENT 14
9.1. Adjustment of auxiliary switches (fig. 10) 15
9.2. Adjustment the keeper /7/ adhesion to the core /18/ 15
9.3. Contact adhesion inspection 15
9.4. Contact gap adjustment in the open position of the circuit-breaker (fig. 11) 15
9.5. Contact gap adjustment in transient condition (fig. 12) 16
9.6. Electromagnetic drive adjustment 16
9.6.1. Adjustment of the gap between the keeper /7/ and the holding core /18/ (fig. 13) 16
9.6.2. Lower fulcrum adjustment for the moving contact arm (fig. 14) 17
9.6.3. Adjustment the initial plunger position (fig. 15) 17
9.7. Electro-pneumatic drive adjustment 17
9.7.1. Lower fulcrum adjustment for the moving contact arm 17
9.7.2. Adjustment the initial piston /59/ position (fig. 16) 18
9.7.3. Adjustment the contact closing speed 18
9.8. Setting the contact force (fig. 17) 18
10. ARC CHUTE 18
10.1. Construction and principle of operation of the arc chutes kbs-0,6 and kbs-0,8 /fig. 26/ 19
10.2. Construction and principle of operation of the arc chute kbd-1,5 /fig. 27/ 19
10.3. Construction and principle of operation of 3 kv arc chute kbdd-3/50b /fig. 28/ 19
11. LIST OF REPLACEABLE AND SPARE PARTS FOR CIRCUIT-BREAKER AND ARC CHUTES 20
11.1. Replaceable parts for circuit-breaker 20
11.2. Replaceable parts for arc chutes 20
11.3. Spare parts for circuit-breakers 20
11.4. Spare parts for arc chutes 21

12. REPLACEMENT OF REPLACEABLE AND SPARE PARTS OF CIRCUIT-BREAKER 22
12.1. Contact replacement 22
12.1.1. Moving contact replacement 22
12.1.2. Fixed contact replacement 22
12.2. Holding coil replacement 22
12.2.1. Circuit-breaker bws with holding current stabilization (fig. 19) 22
12.2.2. Circuit-breaker bws without holding current stabilization (fig. 19) 22
12.3. Closing coil replacement 23
12.4. Solenoid valve replacement (fig. 9) 23
12.5. Replacement of the solenoid valve coil (fig. 9) 24
13. ARC CHUTE MAINTENANCE DURING OPERATION 24
13.1. Maintenance of arc chutes: kbs-0,6 and kbs-0,8 24
13.2. Maintenance of kbd-1,5 arc chute 25
13.3. Maintenance of arc chutes: kbd-3/50b, kbdk-3/50b, kbdp-3/50b, kbdd-3/50b 25
14. PACKAGING, TRANSPORT, STORAGE 26

1. SAFETY CONSIDERATIONS

- Procedures of circuit-breaker installation and disassembly must be carried out in dead condition of the circuit-breaker. The busbars supplying the main circuit of the circuit-breaker must be disconnected and earthed.

- Removing, inspection and installation of arc chutes must be carried out after the busbars supplying the main circuit of the circuit-breaker are disconnected and earthed.

- Installing, commissioning, maintaining or changing these appliances must be carried out only by qualified and suitably trained specialist personnel and under strict observation of national and international safety regulations.

- Do not carry out any setting operations on the circuit-breaker if its main circuit is live.

- Do not use the manual drive lever of the circuit-breaker if its main circuit is live.

- When installing an arc chute, follow the wiring instructions on the arc chute wall.

- Do not touch the holding coil and drive terminals, stabilizer terminals, auxiliary switches or control panel terminals if control voltages are applied.

- Do not use arc chutes for operation with other than rated voltage.

- Do not supply control circuits with higher voitage than determined by their parameters.

- When connecting DC control circuits, maintain polarity according to the diagrams and markings on the terminal strips (of the holding coil, electromagnetic drive, stabilizer, control boards).

- When setting mechanically, do not put your hands into areas of the circuit-breaker where injury is possible when the circuit-breaker is handled or unintentionally opened.

- When checking the overcurrent release of the circuit-breaker (at low voltage), it is recommended to cover up the contact system in order to get protection from possible rejection of arc and metal particles and from glare by electric arc.

- During arc chute regeneration, use a vacuum cleaner to remove the dust arising when the arc chute components are cleaned.

2. APPLICATION

The BWS type single pole, polarized DC high speed circuit-breakers are designed for:

- Switching service and overload currents;
- Short-circuit protection in traction sub-stations and sectioning cabins for long distance trains, trams, suburban trains, underground and on traction vehicles;
- Short-circuit protection for rectifiers and thyristor converters in metallurgy, mining etc.

3. CHARACTERISTICS

Operating conditions

The BWS circuit-breakers are designed for use in rooms at altitudes up to 2000 m above sea level, which are free from dust, gas and vapour, flammable or chemically active. The circuit-breakers are designed for operation in tropical and moderate climatic conditions.

Climatic versions

The BWS circuit-breakers are made in two climatic versions:

- N - for use in the climates:
  Cold Temperate CT;
  Warm Temperate WT;
- T - for use in the climates:
  Warm Damp WDr;
  Warm Damp WDa;

according to the PN-E-045455-21, Std. idt. IEC 721-2-1.

Compliance with standards

- PN-EN-50123-1
- PN-EN-50123-2
- PN-EN-50163
- EN 50124-1

Approvals and certificates

- PKP - Polish State Railways
- RENFE - Spanish Railways
- Slovak Railways
- Hungarian Railways
- BBJ-SEP - safety mark

4. TECHNICAL DATA

Table 1. Technical data

1	Circuit-breaker type			BWS
2	Rated voltage U_{Ne}			600; 825; 1500; 3000 V DC
3	Rated insulation voltage		Main circuit	4000 V
			Auxiliary circuits	500 (800) 1) V
4	Dielectric strength of main circuit insulation		50 Hz, 1 min	15 kV
			1,2 /50 us	35 kV
5	Rated service current i_{Ne}			630, 1000, 1600, 2000, 2500, 3150 A
6	Electrical life at U_e=1,25 U_{Ne}, U= 1,5 W			1000 operating cycles 2)
7	Mechanical endurance			50 000 cycles
8	Making capacity for overload currents			≤ 70 % of release setting current
9	Rated short-circuit breaking capacity			see table 4
10	Opening time (di/dt ≥ 0,5 kA/ms)			≤ 5 ms
11	Voltage of holding coil	with holding current stabilizer		110,220 V DC; 220 VAC
		without holding current stabilizer		55, 110, 220 V DC, 220 VAC
12	Voltage range of holding coil			0,8 - 1,1 3)
13	Time from holding current break to circuit opening	without holding current stabilizer (DC - supply)		≤ 80 ms
		without holding current stabilizer (AC - supply)		≤ 250 ms
		with holding current stabilizer		≤ 150 ms
14	Power consumption of holding coil	with holding current stabilizer		45 W
		without holding current stabilizer		100 W
15	Supply of closing mechanism	Electromagnetic		55, 110, 220, 600 V DC; 220 V AC
		electro-pneumatic	valve coil	24, 48, 55, 110, 220 V DC
			air pressure	0,5 MPa
16	Supply range of closing mechanism	electromagnetic	voltage	0,8 ÷ 1,1
		electro-pneumatic	voltage	0,7 ÷ 1,25
			air pressure	0,7 ÷ 1,2
17	Duration of switching pulse for closing coil			≥ 0,6 s
18	Time from pulse decay to contact closure			≤ 0,6s
19	Power consumption of closing coil	electromagnetic		1600 W
		electro-pneumatic		12W
20	Number of auxiliary switches			6a + 6b or 7a + 7b
21	Parameters of auxiliary switches			I_U=16A U_i = 500V I_e = 4A U_e = 500V AC-15 I_e = 0,5 A U_e = 220V DC-13

1) 800V - without holding current stabilizer, 500V - with holding current stabilizer

2) for the 3150A circuit-breaker - 500 switchings

3) for the circuit-breaker with an electro-pneumatic closing mechanism 0.7 ÷ 1.25

RELEASE SETTING RANGES

Table 2. Release setting ranges

Circuit-breaker rated current	Current setting range				
630 A	360 - 720 A	480 - 960 A	600-1200 A	675 - 1350 A	
1000 A	600 - 1200 A	800 – 1600 A	1000 – 2000 A		
1600 A	960 - 1920 A	1200 - 2400 A	1600 - 3200 A	2000 - 4000 A	
2000 A	1200 - 2400 A	1500-4000 A	1600 - 3200 A	2000 - 4000 A	2000 - 5000 A
2500 A	1800-4000 A	2400 - 4800 A	3000 - 6000 A	4000 - 8500 A	
3150 A	1800-4000 A	2400 - 4800 A	3000 - 6000 A	4000 - 8500 A	

Over-current releases - operation tolerances:

- ± 15% without holding current stabilizer
- ± 2% with holding current stabilizer

Overload capability

The table below shows the times for reaching the permissible temperature-rise limits of the most hot parts, with the following over-currents: 1.2 x INe, 2 x INe, 3 x INe. The overload tests were made for the circuit-breakers with the rated currents 2000, 2500 and 3150 A for two operating modes:

- temperature rise test from a cold state - the circuit-breaker had not been working before the overload test.
- temperature rise test from a steady state - the circuit-breaker had been loaded with rated current before the overload test.

Table 3. Overload capability circuit-breaker 2000, 2500 and 3150A

Circuit-breaker rated current I_{Ne}		2000 A	2500 A	3150 A
Overload from cold state				
Time	1,2 x I_{Ne}	2h	2h	2h
	2 x I_{Ne}	10 min	6 min	10 min
	3 x I_{Ne}	40 s	30 s	35 s
Overload from steady state				
Time	1,2 x I_{Ne}	20 min	75 min	40 min
	2 x I_{Ne}	10s	30 s	60s
	3 x I_{Ne}	4s	7s	9s

Types of arc chutes

KBS-0,6; KBS-0,8 - gap chutes for tram and underground switchboards;

KBD-1,5 - chutes for use in power supply systems for suburban railways, hoisting machines, etc.;

KBD-3/50b - chute for typical sub-stations and sectioning cabins;

KBDk-3/50b - chute with a lower height for sectioning cabins with draw-out switchboards with insulated cell walls;

KBDd-3/50b - chute with the lowest height for RPS/K switchboards with insulated cell walls manufactured by FAE APENA S.A.

KBDp-3/50b - chute for vehicles with additional handles /11/ for mounting in vehicles.

Rated short-circuit breaking capacity

The tests for short-circuit breaking capacity were carried out in the cells of switchboards manufactured by FAE Apena S.A.

Table 4. Rated short-circuit breaking capacity

Type of arc chute	Test voltage	Time constant	Max switching over-voltage	Prospective short-circuit current
KBS - 0,6	750 V	20 ms	1800 V	100kA
KBS - 0,8	1030 V	20 ms	2200 V	80 kA
KBD-1,5	1875 V	20 ms	3000 V	50 kA
KBD - 3/50b	4000 V	10 ms	7000 V	50 kA
KBDk - 3/50b				
KBDd - 3/50b				
KBDp - 3/50b				

Weights of circuit-breakers and arc chutes

Table 5. Circuit-breaker weight without arc chute

Circuit-breaker with holding current stabilizer	
Rated current	Circuit-breaker weight
630 A	115 kg
1000 A	120 kg
1600, 2000 A	130 kg
2500, 3150 A	140 kg

Circuit-breaker without holding current stabilizer	
Rated current	Circuit-breaker weight
630 A	125 kg
1000 A	130 kg
1600, 2000 A	140 kg
2500, 3150 A	150 kg

Table 6. Arc chute weight

Type of arc chute	Arc chute weight
KBS-0,6; KBS-0,8	12 kg
KBD-1,5	18 kg
KBD-3/50b; KBDk-3/50b; KBDd-3/50b; KBDp-3/50b	75 kg

Circuit-breaker overall dimensions

The overall dimensions of BWS circuit-breakers with arc chutes and dimensions of protective zones are shown in fig. 1-4 and in table 7. The various dimensions of BWS circuit-breaker terminals are shown in fig. 1 and in table 8.

Table 7. Dimensions of circuit-breakers with arc chutes and arc zones

Arc chute type	A mm	A1 mm	R1 mm	R2 mm	X1 mm	X2 mm	Y1 mm	Y2 mm	Z1 mm	Z2 mm
KBS - 0,6	850	-	425	615	-	200	-	500	-	600
KBS - 0,8	850	-	425	615	-	200	-	500	-	600
KBD-1,5	930	-	510	720	-	600	-	800	-	900
KBD - 3/50b	1365	435	965	1120	150	350	300	500	700	700
KBDk - 3/50b	1285	355	890	1055	150	350	300	600	700	1000
KBDd - 3/50b	1210	280	820	1000	150	350	300	600	700	900
KBDp - 3/50b	1210	280	820	1000	150	350	300	600	500	1000

Table 8. Variable terminal dimensions

Rated current	D mm	E mm	F mm	G mm	H mm	J mm	K mm	L mm	M mm	N mm	P mm	S mm	0 mm
630 A	575	30	290	30	26	520	-	-	-	8	50	7	11
1000 A	575	30	290	30	26	520	-	-	-	10	50	13	11
1600 A and 2000 A	720	30	290	30	26	515	26	10	50	15	50	-	11
2500 A and 3150 A	706	10	252	50	50	495	50	20	100	20	100	-	17

5. CONSTRUCTION (FIG. 6-19)

A circuit-breaker base /1/ is made of steel sections interconnected with a beam /10/ insulated with heat-shrinkable film. The base /1/ has 4 holes of Ø 13 for securing the circuit-breaker. One of these holes is located on a flexible component. Flexibility is obtained by a cut made in the base. Such a fastening to the foundation eliminates possible stresses that could arise in the circuit-breaker when mounting to out-of-flat foundation and affect the stability of an overcurrent release. An earth M12 screw /12/ is located on the base. Two insulating beams /11/ are fastened to the base IM. A frame /3/ of aluminium alloy is screwed to these beams /11/. The beams /11/ are the main insulation between the circuit-breaker frame /3/ and its base /1/ providing a dielectric strength of 15 kV.

The frame /1/ is a supporting structure for the basic assemblies of the circuit-breaker. A holding magnet core /18/ and a holding coil /16/ are built in the frame /3/. The holding coil /16/ is sealed with epoxy resin that ensures a dielectric strength of 15 kV and creates insulation between the main and control holding circuit. There is a voltaic connection made between the frame 131 and a negative terminal /17/ of the circuit-breaker.

A fixed contact assembly is fastened to the frame /3/ with two insulating beams /19/. These beams create insulation with a dielectric strength of 15 kV between the fixed contact assembly and the circuit-breaker frame /3/. A fixed contact /28/, contact insulating plate /26/, arcing horn /27/ and chute insulating tray /22/ are fastened to a contact plate /20/.

The blow-out system consists of a core /24/, two pole shoes /29/ and two blow-out coils /25/ connected in series or in parallel. The core /24/ has insulation preventing the blow-out coil turns /25/ from a short-circuit and the pole shoes /29/ are mounted through insulating brackets /30/ to the frame /3/.

Insulating trays /43, 44/, an insulating shield /41/ and insulating rings /42/ protect ionized gases from switch-over to the frame /3/.

A positive terminal /21/ of the circuit-breaker is connected through the blow-out coils /25/ to the contact plate /20/ to which the fixed contact /28/ is screwed.

An electromagnetic keeper HI with a moving contact arm /6/ and a moving contact /31/ are borne by control eccentrics /8/ in the circuit-breaker frame /3/. Contact springs /33/ are fastened to the moving contact arm /6/.

The circuit-breakers are equipped with keeper shields /77/ preventing metal impurities arising from the wear of deionization plates and contacts from penetrating the keeper surface.

A flexible joint 141, current circuit bars /5/ and a over-current release coil /15/ connect the moving contact arm /6/ with the negative terminal /17/ of the circuit-breaker.

The overcurrent release consists of a coil /15/ located inside the holding electromagnet core /18/. For a release with upper current setting over 4 kA, an inductive shunt /9/ with a core constructed from laminations is used and connected in parallel to the coil /15/. A sliding core /92/ used to adjust the release operation current is placed inside the coil /15/. The core is slided with a knob /14/ for release current setting. The holding coil /16/ is equipped with an overvoltage protect system in the form of a varistor connected in parallel to the coil.

The circuit-breaker can be equipped with a holding current stabilizer /13/ mounted on the base /1/ to make overcurrent release operation independent of fluctuations of the voltage supplying the holding coil /16/.

Plunger solenoid drive /35/ is fastened to the frame /3/ through an insulating moulded piece /45/. An insulating pusher assembly /86/ transfers drive motion on the moving contact arm /6/. The drive is equipped with a system slowing down the motion of the contacts during the end phase of closing. The system consists of a diode connected in parallel to the coil /47/ and a copper sleeve in the coil /47/ that performs the function of a shorted coil. The diode is mounted on a terminal strip. Additionally, the construction of the insulating pusher assembly 786/ causes a change in the fulcrum of the moving contact arm /6/ at the end phase of closing and this results in additional slowing down of the motion of the moving contact arm /6/ when closing the circuit-breaker and, when closing the circuit-breaker by short-circuit, this results in faster opening of the circuit-breaker.

A bumper /51/ limits the plunger when the drive is off.

An electro-pneumatic drive can be used instead of the electromagnetic drive. The electro-pneumatic drive consists of a solenoid valve /60/ and cylinder /56/ with piston /59/ transferring force through the insulating pusher assembly /86/ to the moving contact arm /6/.

The dielectric strength of the drive (both the electromagnetic and electro-pneumatic one) towards the circuit-breaker frame is 15 kV, however the dielectric strength of the electromagnetic drive coil and the valve coil towards the drive body is 4 kV.

The circuit-breaker is equipped with an auxiliary switch assembly /2/ and mechanical indicator of contact /34/ position.

The arc chute /23/ has a bearing system mounted by rotary motion on axis /32/ and it rests in an insulating tray /22/.

6. PRINCIPLE OF OPERATION (FIG. 19)

The operation of the BWS circuit-breaker is based on the principle of magnetic holding keeper - that is automatic opening takes place when the magnetic flux /$Ø_w$/ generated by the current flowing through the coil of the over-current release /28/ sufficiently weakens the magnetic flux of the holding coil /$Ø_t$/. When closed the keeper /7/ adheres tightly to the core of the holding electromagnet /18/. The holding coil /16/ generates a magnetic flux /$Ø_t$/ flowing through the core /18, 89/ and keeper /7/. The main current flows through the over-current release coil /15/ (or part of it in the case of the inductive shunt /9/ circuit-breaker), which generates a flux /$Ø_w$/ going through the keeper /7/, however its direction is opposite to that of the holding flux /$Ø_t$/. The difference between the fluxes determines the holding force of the keeper /7/, which is pulled off by a spring /33/. If the holding force drops below the force from the spring /33/, the keeper /7/ is pulled off the core /18/ and the contacts are opened.

For the higher ranges of over-current releases an inductive shunt /9/ is used. In a steady state it causes a current flow which is dependent on the resistance of the shunt /9/ and release line /15/, whereas in a dynamic state of current rise is dependent of their inductances.

The operating current of the over-current release /15/ is set by means of a moving core /92/, adjusted with an adjusting handwheel./14/.

The BWS circuit-breaker is polarized. It means, that automatic opening of the circuit-breaker resulting from a current, higher than the current set on the over-current release /15/, takes place only when the direction of the main current flow corresponds to the polarity marked on the circuit-breaker terminals and the voltage at the holding coil /16/ has the polarity that corresponds to the markings at its terminals. In the case of current flow in the opposite direction or change in the supply voltage polarity at the holding coil, the circuit-breaker will not open automatically.

6.1. CLOSING CIRCUIT-BREAKERS WITH ELECTROMAGNETIC DRIVE

After voltage is applied to the drive coil /47/, the plunger /48/ is pulled to the drive core /49/ and it transfers motion with the insulating pusher assembly /86/ through a pin /85/ to the moving contact arm /6/ that pushes the keeper /7/ connected to it to the core /18/. The moving contact /31/ is then about 6 mm away from the fixed contact /28/ when contacts are new and 10 mm away when contacts are worn.

After power supply to the drive coil /47/ is disconnected, the moving contact /31/ turns around the axis /93/ by the action of contact springs /33/ and it lies down on the fixed contact /28/ with a pressing force of 260^{+40}_{-20} N.

The speed at which the contacts are closed depends on the speed at which the drive plunger /48/ withdraws and the place of support of the moving contact arm /6/ by the withdrawing insulating pusher assembly /86/. In order to obtain adequate speed of withdrawing in respect of the drive plunger /48/, a copper sleeve and a shunt diode for the drive coil are used in the coil /47/. They cause slowing down of magnetic flux decay.

Additionally, the construction of the insulating pusher assembly /86/ causes a change in the fulcrum of the moving contact arm /6/ at the end phase of closing - when the distance between the moving contact /31/ and the fixed one /28/ is about 2 mm for new contacts. Shifting down the fulcrum of the moving contact arm /6/ changes the kinematics of the contact system, due to this the movement of the moving contact arm /6/ is even slower when closing the circuit-breaker and the circuit-breaker is opened faster when closing the circuit-breaker by short-circuit.

Note:

Supply voltage of a DC drive must have its polarity set according to the indication on its terminal strip, otherwise the discharge diode will be damaged. The closing coil is not intend for continuous operation.

6.2. CLOSING CIRCUIT-BREAKERS WITH ELECTRO-PNEUMATIC DRIVE

After voltage is applied to the solenoid valve /60/, compressed air causes piston /59/ movement that is transferred with the insulating pusher assembly /86/ through a pin /85/ to the moving contact arm /6/. The moving contact arm /6/ pushes the keeper HI connected to it to the core /18/. The moving contact /31/ is then about 6 mm away from the fixed contact /28/ when contacts are new and 10 mm away when contacts are worn. After power supply to the solenoid valve is disconnected, the moving contact turns around the axis /93/ by the action of contact springs /33/ and it lies down on the fixed contact /28/ with a pressing force of 260^{+40}_{-20} N. The speed at which the contacts are closed depends on the speed of air flowing out of the cylinder /56/ and the place of support of the contact by the withdrawing insulating pusher assembly. In order to obtain adequate speed of air pressure decrease in the cylinder /56/, a throttling screw /61/ is used in the solenoid valve. In general, a circuit-breaker with pneumatic drive is closed with a push button that applies a short voltage pulse directly to the solenoid valve coil /67/. The solenoid valve coil is not polarized and similarly the coil of the electromagnetic drive is not intended for continuous operation.

6.3. CLOSING CIRCUIT-BREAKERS WITH HAND LEVER

During inspection or setting, a circuit-breaker can be closed with a hand lever /36/. For this purpose, the bent end of the hand lever is placed into a hole in a front plate /53/ electromagnetic drive. Pressing the hand lever down results in a shift of the plunger /48/ just as while electromagnetic closing.

In the case of electropneumatic drive, a clamping screw M6 for a flap /55/ must be loosened and then the flap must be moved. Insert the hand lever /36/ into a hole exposed in this way and press it down to move a insulating pusher assembly /86/. Note: Due to safety considerations, a circuit-breaker must not be closed manually if its main circuit is live.

6.4. TRIPPING-OUT

A circuit-breaker opens automatically if the current flowing in the main circuit according to the polarity indicated on the circuit-breaker exceeds a value set on the overcurrent release.

6.5. INTENTIONAL OPENING

A circuit-breaker can be opened intentionally by cutting off electric current in the holding coil /16/ supply system.

6.6. CIRCUIT-BREAKER CONTROL USING CONTROL BOARD

A circuit-breaker can be controlled with one of the following control boards:

- BWTS - a basic control board with electromechanical switches. It can be used for all versions of the circuit-breaker. Supply voltages of the control board can be 55, 110, 220V DC and 220V AC. In the case of the 220V AC control board, the voltage of the drive and holding system must be 220V AC, too;
- BWTS/N - a control board made using an electronic relay block. The control board supply voltage is 220V DC. The control board can be used for the circuit-breakers where the voltage for the drive and holding system is also 220V DC;
- BWTS-B - a control board with electromechanical switches and a by-pass system. Control board supply voltages can be 110 and 220V DC or 220V AC. The control board can be used for the circuit-breakers with holding current stabilizers where the voltages of the drive and holding systems are also 110 and 220V DC or 220V AC, respectively;
- BWTS/N-B - a control board made using an electronic relay block and a by-pass system. The supply voltage of the control board is 220V DC. It can be used for circuit-breakers with holding current stabilization where the voltage of the drive and the holding systems is 220V DC.

The overall dimensions and values of supply voltages for control boards are shown in fig. 5 and in tables 9 and 10. Terminal diagrams and schematic diagrams for the control boards are shown in fig. 20÷25.

Each of the boards prevents the so called "pumping" on short-circuit. The protection against "pumping" is based on the following principle. If the circuit-breaker is closed with a continuous pulse and tripping-out occurs, the circuit-breaker will not switch on again. In such a case, the circuit-breaker can be closed again only after the continuos pulse is cut off and then a new pulse is applied. All the control boards protect also against drive start-up when the circuit-breaker is closed.

The closing coil is intended for short operation, therefore, in each control board, it is protected with a thermal relay or MCB. The thermal relay is equipped with a lock to prevent the drive from switching on again without previous unlocking. Before unlocking, check the reason for relay actuation. It is also possible to switch off the locking function by blockage of the lock. In such a case, you can switch on the drive again after the relay bimetal is cooled. Switch on the MCB after checking the reason of its actuation.

The BWTS-B and BWTS/N-B boards have an additional protection of the holding system that operates in case of current consumption increase in the holding current stabilizer. The protection will result in switching off the stabilizer and simultaneously, switching the holding coil to a by-pass supply circuit (a resistor connected in series to the holding coil circuit). Actuation of the protection does not result in opening of the working circuit-breaker. The holding coil can be switched over manually to the by-pass supply circuit by switching the MCB (QF). The BWTS-B and BWTS/N-B boards have auxiliary switch (K3) terminals led to a signalling system to indicate operation of the protection system. The signalling system should be used because holding coil operation in the by-pass system is connected with no current stabilization in the holding coil and it increases discrepancies in the operation of the overcurrent release. Such a condition is treated as an emergency and it means that the stabilizer must be replaced.

For the control boards BWTS and BWTS-B is used an auxiliary switch with operation program A.

For the control boards BWTS/N and BWTS/N-B is used an auxiliary switch with operation program B.

Markings used in diagrams (fig. 20÷25)

1 ÷18	- terminal strip
CT	- holding coil
CZ	- closing coil
ST	- current stabilizer
Q1	- auxiliary switch of BWS
QF	- MCB
K1	- contactor
K2, K3	- relays
KF	- thermal relay
51	- push-button with NO contact
52	- push-button with NC contact
RF	- varistor
C	- capacitor
D1	- diode
R	- resistor
D2, D3	- bridge rectifiers
BPE-31A	- block of electronic relays

Table 9. Overall dimensions of control boards

Control board	B1 mm	C1 mm	D1 mm	E1 mm	F1 mm	G1 mm	H1 mm	J1 mm	ØT mm
BWTS direct current	168	270	240	250	12	8	13	168	6,5
BWTS alternating current	250	230	230	210	10	8	13	92	6,5
BWTS/N	280	280	256	220	12	10	13	145	6,5
BWTS - B	280	280	256	220	12	8	13	145	6,5
BWTS/N - B	280	280	256	220	12	8	13	145	6,5

Table 10. Rated voltage of control boards

Control board	Rated voltage			
BWTS	55V DC	110V DC	220V DC	220V DC
BWTS/N	220V DC			
BWTS-B	110V DC	220V DC		220V AC
BWTS/N - B	220V DC			

7. CIRCUIT-BREAKER INSTALLATION

The circuit-breaker is fastened to the foundation with four M12 screws. An earth terminal with an M12 screw /12/ is used to earth the circuit-breaker base.

The protective zone for the earthed parts is given in the table 7 and shown in fig. 1÷4.

Connection busbars should be led to the rear along the longitudinal axis of the circuit-breaker. They must be connected in accordance with the polarity of the circuit-breaker.

When installing the circuit-breaker in a switch board cubicle, pay attention to maintain the clearance distances and to the layout of cables or supply busbars.

After an arc chute is placed on a circuit-breaker, it is necessary to check the arc chute position /23/ in the insulating tray /22/ - the arc chute must be strictly adherent to the insulating tray. Connect the arc chute wires to the circuit-breaker according to the instructions on the arc chute.

Then check the operation of the circuit-breaker (closing and opening); the circuit-breaker contacts must not brush against arc chute walls or negative copper arcing horn. Set the required value of the overcurrent release with the knob /14/.

The polarity of the supply circuits of the closing and holding coils must conform to the markings on the terminal strips.

The control circuits of the circuit-breakers with electromagnetic drive can be supplied through one of the following control boards: BWTS, BWTS/N, BWTS-B or BWTS/N-B installed separately in a switch board cubicle.

Before a circuit-breaker is put into service, remove vaseline from the keeper /7/ and core /18/ surfaces by rubbing the surfaces with a dry cloth.

8. CIRCUIT-BREAKER MAINTENANCE

Usual wear and tear of circuit-breaker contacts and of an arc chute occurs during their operation, so they should be checked periodically and replaced if necessary by service personnel.

To check the degree of contact wear, measure the gap between contacts in the transient state as described in point 9.5. If the gap increases up to about 10 mm, then the contacts should be replaced with new ones and the circuit-breaker should be set as in point 9.

The wear of arc chutes is determined visually. The construction, evaluation of the degree of arc chutes wear and methods of their regeneration are given in point 13.

9. CIRCUIT-BREAKER ADJUSTMENT

The correct adjustment of a circuit-breaker is a condition of its reliable operation. Apart from the contacts and the arc chute, no other parts are subject to major wear, however they can suffer from accidental damage or maladjustment of the circuit-breaker can occur. In such cases replacement of the damaged parts is necessary as well as readjustment of the circuit-breaker. This should be carried out according to the following description order.

9.1. ADJUSTMENT OF AUXILIARY SWITCHES (FIG. 10)

Auxiliary switches are set using an insulator 1521. Carry out the following actions:

- loosen the lock-nuts /74/ (the upper one with a left-hand thread),
- close the circuit-breaker,
- turn the insulator /75/ until the normally open contact /72/ has about 2mm overtravel on switches no. 2÷6 (or 2-7) /73/ and about 4 mm on switch no.1 /76/. If the values obtained are different, suppress the differences by individual switch setting in oval holes used to their fastening.

The overtravel is identified as a slot between the contact bridge /72/ and the base /71/ of the normally open contact. After setting, tighten up the lock-nuts /74/.

9.2. ADJUSTMENT THE KEEPER /7/ ADHESION TO THE CORE /18/

Before every circuit-breaker adjustment, clean the keeper /7/ and core /18/ surfaces and check their adhesion in the closed position of the circuit-breaker. The keeper /7/ should adhere to the core /18/ on the whole surface. When checking, use a source of light placed opposite to the observer. If the light is visible between the keeper /7/ and the core /18/, adjustment is necessary. Carry out the following actions with the circuit-breaker in the closed position:

- reduce tension of the springs /33/ by loosening the nuts /37/,
- loosen the screws (do not unscrew them completely) retaining both eccentrics /8/,
- turn the eccentrics /8/ until the light becomes invisible,
- tighten the screws retaining the eccentrics /8/,
- increase tension of the springs /33/ - see point 9.8.

After adjustment, open the circuit-breaker, then close it and check the adhesion between the keeper /7/ and the core /18/ once again.

9.3. CONTACT ADHESION INSPECTION

New or replaced contacts should adhere to each other with at least 75% of their surfaces and their contact resistance should not exceed values given in the table 11. An inspection of contact adhesion surface is carried out by insertion of carbon paper with thin sheet of paper between the contacts, closing the contacts and evaluation of the traces left on the paper.

During operation, if the contact resistance increases too high, file the contacts with a fine file until a proper value of the contact resistance is obtained. When filing, pay attention that filings do not contaminate the circuit-breaker. After that blow out the circuit-breaker with clean and dry air.

9.4. CONTACT GAP ADJUSTMENT IN THE OPEN POSITION OF THE CIRCUIT-BREAKER (FIG. 11)

In the open position of the circuit-breaker, the gap between the fixed /28/ and the moving contact /31/ should be 35±1 mm for new contacts. This is obtained by insertion of suitable shims /79/ between the buffer /78/ and the frame /3/.

Table 11. Permissible voltage drops in contacts for rated currents of the circuit-breaker.

Circuit-breaker rated current [A]	Test current [A]	Permissible voltage drop in a contact [mV]	Permissible contact resisance [μΩ]
630	630	20	32
1000	1000	35	35
1600	1600	35	22
2000	2000	40	20
2500	2500	30	12
3150	3150	25	8

9.5. CONTACT GAP ADJUSTMENT IN TRANSIENT CONDITION (FIG. 12)

The contact gap in the transient position is measured between the fixed and moving contact when the keeper is attached to the holding core and the drive is operated. This gap is set with a pull rod /82/. For this purpose:

- apply supply voltage to the holding coil /16/,
- insert a gauge of thickness 7 mm between the main contacts,
- using the manual drive /36/, bring the keeper /7/ to the holding core /18/,
- remove split cotters from the pin /81/,
- remove the pin /81/ from the pull rod /82/, loosen the lock-nut /80/,
- turn the pull rod /82/ to the left or to the right until the slack is taken in (at the side of the moving contact arm /6/), between the pull rod /82/ and the pin /81/ placed in position again,
- tighten the lock-nut /80/,
- secure the pin /81/ with the split cotters at both ends,

A contact gap of 7 mm in setting condition results in 6±1 mm gap in working condition after the circuit-breaker is set completely and closed with electromagnetic or electro-pneumatic drive.

Due to contact wear, the gap in transient condition increases and when it reaches 10 mm, the contacts should be replaced with new ones.

A contact gap smaller than 5 mm in transient/working condition can result in arc-over between the contacts during closing at $U_e \geq 3000V$ (particularly, when some irregularities occur on the worn contact surface).

9.6. ELECTROMAGNETIC DRIVE ADJUSTMENT

9.6.1. ADJUSTMENT OF THE GAP BETWEEN THE KEEPER /7/ AND THE HOLDING CORE /18/ (FIG. 13)

Adjustment of this gap is carried out with a plunger /48/. Switch off the supply voltage for the holding coil /16/, loosen the lock-nut /50/ and turn the plunger /48/ to the left or to the right until the gap between the keeper /7/ and the core /18/ is 0,5 mm when pressing the manual drive lever /36/ home. Then turn the plunger by half-turn to the left and tighten the lock-nut /50/, apply voltage to the drive coil /47/ and check if the gap between the keeper 171 and the core /18/ is within the range of 0,3÷0,5 mm.

Measure the gap with a feeler gauge. If the above mentioned gap is missing, then the keeper /7/ strikes the core /18/ during closing with the electromagnetic drive and this results in circuit-breaker maladjustment and damage to the holding surface of the keeper /7/ and the core /18/. A gap greater than 0,5 mm can result in problems with catching the keeper /7/ during circuit-breaker closing.

9.6.2. LOWER FULCRUM ADJUSTMENT FOR THE MOVING CONTACT ARM (FIG. 14)

Lower fulcrum adjustment for the moving contact arm /6/ is carried out with the adjusting screw /84/ in the insulating pusher assembly /86/.

For this purpose, loosen the lock-nut /83/, insert a gauge of thickness 2 mm between the contacts, switch on supply voltage for the holding coil /16/ and close the circuit-breaker. Then, while loosening or tightening the adjusting screw /84/, obtain support of the moving contact arm /6/ simultaneously in two points: upper one - axis /85/ and lower one - adjusting screw /84/ when pressing the manual drive lever /36/ and when the circuit-breaker contacts are 2mm (gauge thickness) apart. Tighten the lock-nut /83/ to secure the adjusting screw /84/ from unscrewing during operation.

Check the correctness of the lower fulcrum adjustment by closing the circuit-breaker with the manual drive /36/ and then by slowly withdrawing the insulating pusher assembly /86/. When the circuit-breaker contact gap is 1,5÷2,5 mm, the moving contact arm /6/ should be supported at both the lower and upper fulcrum (while closing the circuit-breaker with the manual drive /36/ and when the keeper /7/ is pulled, reduction of the pressing force of the moving contact arm /6/ onto the insulating pusher assembly /86/ is felt while slowly withdrawing the manual drive lever /36/). When the contacts are closed, the moving contact arm /6/ should be supported in the lower fulcrum only.

9.6.3. ADJUSTMENT THE INITIAL PLUNGER POSITION (FIG. 15)

Open the circuit-breaker. Increase tension of the contact springs /33/ until the moving contact /31/ rests on the buffer /78/. An initial plunger /48/ position is set with the buffer /51/. When the contacts are fully open, set the buffer /51/ with the shims /52/ so that the "L" gap between the fork of the insulating pusher assembly /86/ and the pin /85/ is 2-3 mm.

After this gap is set, tighten the screw fastening the buffer /51/. Check this gap by pushing the plunger /48/ manually until contact between the fork of the insulating pusher assembly /86/ and the pin /85/ is felt and by measurement of the gap between the plunger /48/ and the buffer /51/. If the gap is too big, there is a danger of the fork dropping out from the pin when the circuit-breaker is closed, however, if the gap is missing, this results in breaking the fork of the insulating pusher assembly /86/ by the pin /85/ when opening the circuit-breaker.

9.7. ELECTRO-PNEUMATIC DRIVE ADJUSTMENT

9.7.1. LOWER FULCRUM ADJUSTMENT FOR THE MOVING CONTACT ARM

This should be done as in the circuit-breaker with the electromagnetic drive - see point 9.6.2.

9.7.2. ADJUSTMENT THE INITIAL PISTON /59/ POSITION (FIG. 16)

This is carried out when the circuit-breaker is open. The initial piston /59/ position is set with a stop screw /58/. When the contacts are fully open and the piston /59/ rests on the stop screw /58/, the "L" gap between the fork of the insulating pusher assembly /86/ and the pin /85/ should be 2÷3 mm. For this purpose, tighten the stop screw /58/ until the slack is taken in between the fork of the insulating pusher assembly /86/ and the pin /85/ and then unscrew it by 1,5 turn. Secure this position with the lock-nut /57/. In addition, check the gap visually while moving the manual drive lever /36/.

If the gap is too big, there is a danger of the fork dropping out from the pin when the circuit-breaker is closed, however, if the gap is missing, this results in breaking the fork of the insulating pusher assembly /86/ by the pin /85/ when opening the circuit-breaker.

9.7.3. ADJUSTMENT THE CONTACT CLOSING SPEED

The speed at which the contacts are closed in the circuit-breaker depends on the speed at which the piston /59/ is withdrawn in the drive and the latter speed depends on the speed of pressure decrease in the drive cylinder /56/. Use the screw /61/ throttling the air flow out from the solenoid valve /60/ to set the contact closing speed.

Air flowing out too fast from the solenoid valve can result in the keeper /7/ being separated when the contacts touch each other, however air flowing out too slowly can result in too slow contact closing and as a consequence of this, an arc-over before contact is obtained.

9.8. SETTING THE CONTACT FORCE (FIG. 17)

The operating contact force is 260^{+40}_{-20} N. The method of measurement is shown in fig. 17. The force value is set with the nut /37/. When the circuit-breaker is closed, attach thin wire or thin strong string below the lower contact edge. The wire or string should be tangent to the axis of the pin /32/ that bears the arc chute. Pull back the moving contact with a dynamometer until the moving contact does not touch the fixed contact. The moment when contact is lost can be recognized using an electric method, e.g.: with a lamp, ohmmeter or mechanically, while pulling out a slip of thin paper from between the contacts. Secure the nut /37/ with the lock-nut after force is set.

10. ARC CHUTE

The circuit-breakers BWS can be equipped with arc chutes of the following types:

a/ slotted arc chutes

KBS-0,6; KBS-0,8

b/ arc chutes with deionization plates

KBD-1,5

KBD-3/50b; KBDp-3/50b; KBDk-3/50b; KBDd-3/50b

The numbers 0,6; 0,8; 1,5; 3 indicate rated voltage in kV.

The breaking capacity values of the circuit-breakers with the above-mentioned arc chutes are given in table 4.

10.1. CONSTRUCTION AND PRINCIPLE OF OPERATION OF THE ARC CHUTES KBS-0,6 AND KBS-0,8 /FIG. 26/

The slot-wedge KBS-0,6 and KBS-0,8 arc chutes consist of external plates /104, 105/, a middle plate /103/ splitting the arc chute into two constituent chambers of reduced width, a copper arcing horn /102/, a hinge /100/ with bearing hole, a wire /101/ connecting the negative terminal /17/ with the arcing horn /102/ and wedges /106/ - two in the KBS-0,8 arc chute and three in the KBS-0,6 arc chute.

In the KBS-0,6 and KBS-0,8 arc chutes, arc suppression occurs mainly due to elongation and cooling of the electrical arc burning in the arc chute.

10.2. CONSTRUCTION AND PRINCIPLE OF OPERATION OF THE ARC CHUTE KBD-1,5 /FIG. 27/

The KBD-1,5 arc chute consists of external plates /112, 110/, an arcing horn /109/, a hinge /108/ with a bearing hole, a wire /101/ connecting the negative terminal with the arcing horn /109/ and deionization plates

10.3. CONSTRUCTION AND PRINCIPLE OF OPERATION OF 3 KV ARC CHUTE KBDd-3/50b /FIG. 28/

The arc chute consists of two adjacent constituent chambers electrically connected in series. They have an insulating middle partition /125/ that is a common wall for both constituent chambers. In the constituent chambers are following arcing horns:

- in the first chamber - arcing horn with its protection /120/ connected to the "+" terminal and internal arcing horn;
- in the second chamber - arcing horn connected to the "-" terminal and internal arcing horn /124b/.

Both of these arcing horns are electrically join together with a copper link (subassembly 124). The arc guides /119, 122/ force to run the electrical arc into both inlets of consistent chambers. In the upper part of arc chutes are placed deionization /114, 115/ and insulating plates /113/.

The insulating partition /125/ is ended with a roof /126/ preventing a flash-over between both chambers.

The 3 kV arc chutes (KBD-3/50b,KBDk-3/50b,KBDd-3/50b,KBDp-3/50b) differ in height from each other.

The 3 kV arc chutes (KBD-3/50b, KBDk-3/50b, KBDd-3/50b) are fitted with metallic screen protecting against an influence of external field.

The arc is extinguished in the deionization plates /114, 115/, where on each plate arises voltage drop of about 40 V. The insulating plates /113/ lengthen the arc and improve the breaking capacity. During the current breaking in both constituent chambers the arc creates two windings causing an extreme strong magnetic blowout.

11. LIST OF REPLACEABLE AND SPARE PARTS FOR CIRCUIT-BREAKER AND ARC CHUTES

11.1. REPLACEABLE PARTS FOR CIRCUIT-BREAKER

1. fixed contact 3150 A /28/
2. fixed contact 2500 A /28/
3. fixed contact 2000 - 630 A /28/
4. narrow fixed contact 2500 A /28/
5. narrow fixed contact 2000 A /28/
6. narrow fixed contact 2000 - 630 A /28/
7. moving contact 3150 A /31/
8. moving contact 2500 A /31/
9. moving contact 2000 + 630 A /31/
10. narrow moving contact 3150 A /31/
11. narrow moving contact 2500 A /31/
12. narrow moving contact 2000 - 630 A /31/
13. arc chute KBD-3/50b /23/
14. arc chute KBDk-3/50b /23/
15. arc chute KBDd-3/50b /23/
16. arc chute KBDp-3/50b /23/
17. arc chute KBD-1,5 /23/
18. arc chute KBS-0,8/23/
19. arc chute KBS-0,6/23/

11.2. REPLACEABLE PARTS FOR ARC CHUTES

ARC CHUTES: KBD-3/50b, KBDk-3/50b, KBDp-3/50b, KBDd-3/50b:

20. short deionization plate + insulating plate /114, 113/
21. long deionization plate + insulating plate/115,113/
22. insulating plate/113/

ARC CHUTES: KBD-1,5:

23. deionization plate /111/

11.3. SPARE PARTS FOR CIRCUIT-BREAKERS

24. special contact screw /196/
25. arc horn (for arc chutes: KBD-3/50b, KBDk-3/50b, KBDd-3/50b, KBDp-3/50b) /27/
26. arc horn + contact shield (for arc chutes: KBS-0,6; KBS-0,8) /27/
27. arc horn + contact shield (for arc chutes KBD-1,5) /27/
28. right tray /43/
29. left tray/44/
30. insulating shield/41/
31. insulating rings /42/
32. cover plate (for arc chutes: KBD-3/50b, KBDk-3/50b,KBDd-3/50b, KBDp-3/50b) /26/

33. cover plate (for arc chutes: KBD-1,5) /26/
34. cover plate (for arc chutes: KBS-0,6; KBS-0,8) /26/
35. insulating tray 3150/2500 A /22/
36. insulating tray 2000 + 630 A /22/
37. holding coil/16/
38. closing coil IA7I
39. solenoid valve /60/
40. solenoid valve coil /67/
41. diodeD22-10-12
42. varistor
43. bridge rectifier
44. board with bridge rectifier and varistor
45. LK type auxiliary switch - operation program A /73/
46. LK type auxiliary switch - operation program B /76/
47. indicator unit
48. current stabilizer /13/

Other components and subassemblies at Customer's request.

11.4. SPARE PARTS FOR ARC CHUTES

ARC CHUTES KBD-3/50b, KBDk-3/50b, KBDp-3/50b, KBDd-3/50b:

49. middle plate /125/
50. right wall /117/
51. left wall /127/
52. minus horn /118/
53. right horn /120/
54. internal horn /124/
55. roof for arc chutes KBD-3/50b /126/
56. roof for arc chutes KBDk-3/50b /126/
57. roof for arc chutes KBDp-3/50b, KBDd-3/50b /126/

ARC CHUTES: KBD-1,5:

58. left wall
59. right wall
60. deionization plate /111/

ARC CHUTES: KBS-0,6; KBS-0,8:

61. middle plate /103/
62. right wall /104/
63. left wall/105/

12. REPLACEMENT OF REPLACEABLE AND SPARE PARTS OF CIRCUIT-BREAKER

12.1. CONTACT REPLACEMENT

If replacement of the main contact is necessary, simultaneous replacement of both contacts, i.e. the fixed one (28) and the moving one (31) is recommended. After contact replacement, check if the circuit-breaker settings are correct and follow the procedures described in points 9.2., 9.3. and 9.4. if necessary.

12.1.1. MOVING CONTACT REPLACEMENT

Draw the arc chute aside and unscrew the two M10 screws with a socket wrench. The longer screw is a special one of high strength and it fits the contact holes. It must not be replaced with a screw of another type. After contact replacement, tighten the screws securely.

12.1.2. FIXED CONTACT REPLACEMENT

Unscrew the screw fastening the arcing horn (or contact shield) /27/, remove the arcing horn (or contact shield) /27/, unscrew the 2 screws fastening the fixed contact /28/. Replace the fixed contact /28/ and carry out the above procedure in reverse order.

12.2. HOLDING COIL REPLACEMENT

12.2.1. CIRCUIT-BREAKER BWS WITH HOLDING CURRENT STABILIZATION (FIG. 19)

In order to replace the holding coil in the circuit-breaker BWS with holding current stabilization, proceed as follows:

- unscrew the power leads of the coil from the stabilizer /13/;
- unscrew the two M12 screws fastening the core yoke /89/;
- disassemble the core yoke /89/,
- replace the coil /16/;
- install the core yoke /89/ and screw it slightly with the two M12 screws /88, 91/ (the core yoke should be able to move);
- connect the power leads of the coil to the stabilizer /13/ (maintaining proper polarization);
- switch on the holding coil /16/ to draw the core yoke /89/ and fit it to the core;
- tighten the M12 screws /88, 91/ fastening the core yoke /89/.

The overcurrent release range can change slightly as a result of coil replacement. So, it is recommended to check that range.

When checking the release, the value of the voltage supplying the current stabilizer should be as in table 12 and operating contact force should be 260^{+40}_{-20} N: The range of release operation can be corrected with the threaded core /90/.

12.2.2. CIRCUIT-BREAKER BWS WITHOUT HOLDING CURRENT STABILIZATION (FIG. 19)

In order to replace the holding coil in the BWS circuit-breaker without holding current stabilization, proceed as follows:

- unscrew the wires from the coil terminals /16/,
- unscrew the two M12 screws fastening the core yoke /89/,
- disassemble the core yoke /89/,

- replace the coil /16/,
- install the core yoke /89/ and screw it with the two M12 screws,
- screw the wires to the coil terminals (maintain polarization when connecting the power leads).

The overcurrent release range can change slightly as a result of coil replacement. So, it is recommended to check that range.

When checking the release, the value of the holding coil current should be as in table 12 and the operating contact force should be 260^{+40}_{-20} N. The range of release operation can be corrected with the threaded core /90/ (precisely) and non-magnetic separators /95/ (flux attenuation).

Table 12. Checking overcurrent releases in BWS circuit-breakers - test current values for holding coils depending on holding system rated voltage.

No.	Rated voltage of holding system	Holding coil current	Remarks
1	48V DC	2.1A DC	circuit-breaker without holding current stabilizer
2	55V DC	1.75A DC	
3	110V DC	0.9A DC	
4	220V DC	0.45A DC	
5	660V DC	0.15A DC	
6	220V AC	0.4A AC[1)]	
7	110V AC or DC	0.56A DC	circuit-breaker with holding current stabilizer
8	220V AC or DC	0.28A DC	

[1)] current on the AC side

12.3. CLOSING COIL REPLACEMENT

In order to replace the closing coil /47/, proceed as follows:

- unscrew the wires from the coil terminals,
- unscrew the four M10 nuts clamping the front steel plate /53/ of the drive and disassemble it,
- replace the coil /47/ with a new one,
- install the front steel plate /53/ and tighten the four clamp nuts,
- connect the power leads to the coil terminals /47/ maintaining proper polarization.

12.4. SOLENOID VALVE REPLACEMENT (FIG. 9)

In order to replace the solenoid valve /60/, proceed as follows:

- unscrew the connector terminals /62/ from the solenoid valve coil /67/,
- unscrew the two M8 screws clamping the solenoid valve to the electro-pneumatic drive body /56/,
- replace the solenoid valve,
- tighten the solenoid valve /60/ to the drive body /56/,
- connect the terminals of the connector /62/.

12.5. REPLACEMENT OF THE SOLENOID VALVE COIL (FIG. 9)

In order to replace the solenoid valve coil, proceed as follows:

- unscrew the connector terminals /62/ from the solenoid valve coil /67/,
- unscrew the screw /63/ fastening the coil core /66/,
- unscrew the 2 screws /69/ fastening the keeper limiter /68/ to the solenoid valve body /70/,
- remove the keeper /65/ and the keeper limiter /68/,
- unscrew the coil core /66/ with a 22 wrench,
- replace the solenoid valve coil /67/.

After replacement, follow the same procedure in reverse order and set the play levels of the keeper as follows:

play level b: set play level b - 0.5 mm by moving the armature limiter /68/. After setting, tighten the screws /69/,

play level a: press the armature to the coil core with your fingers and set play level a=1 mm with the screw /61/.

13. ARC CHUTE MAINTENANCE DURING OPERATION

NOTE:

When removing, inspecting and installing of arc chutes, the circuit-breaker must be disconnected on both sides and grounded.

13.1. MAINTENANCE OF ARC CHUTES: KBS-0,6 AND KBS-0,8

Arc chute inspection.

Arc chute inspection must be carried out at least once a year. If no considerable signs of arc chute wear (such as: "pearling", sootiness at internal sides of the walls, burn-out of wedge ferrules, external wall or middle plate cracking) are found, then the arc chute operation can be continued. If considerable signs of wear occur, disassemble the arc chute, evaluate its condition and, if necessary, regenerate it.

After each repeated switching off occurring as a result of several hard short-circuits in short (few seconds) time intervals, arc chute inspection is suggested and, if necessary, the arc chute should be disassembled to evaluate its wear condition.

Arc chute wear condition evaluation and regeneration.

Middle plate, arc chute right and left walls

Clean the surfaces of the middle plate and right and left walls with a scraper to remove "pearling", copper tarnish and carbon black while using a vacuum cleaner to remove dust arising at the same time.

Negative horn of arc chute

Remove the remaining contact material from the horn, which settles there during switching off.

Wedges

Clean the wedges and their ferrules of contact material tarnish and carbon black.

Arc chute release for operation.

Make sure that the arc chute, after screwing, is seated correctly in the insulating tray of the circuit-breaker and that the flexible cable is connected in accordance with the drawing placed on the arc chute. Carry out a voltage test on the circuit-breaker with 3 kV, 50 Hz, 1 min voltage.

13.2. MAINTENANCE OF KBD-1,5 ARC CHUTE

Arc chute inspection.

Arc chute inspection must be carried out at least once a year. If no considerable signs of arc chute wear (such as: "pearling", sootiness at internal sides of the walls, burn-out of deionization plates, external wall cracking) are found, then the arc chute operation can be continued. If considerable signs of wear occur, disassemble the arc chute, evaluate its condition and, if necessary, regenerate it.

After each repeated switching off occurring as a result of several hard short-circuits in short (few seconds) time intervals, arc chute inspection is suggested and, if necessary, it should be disassembled to evaluate its wear condition.

Arc chute wear condition evaluation and regeneration.

Arc chute right and left walls

Clean the surfaces of the right and left walls with a scraper to remove "pearling", copper tarnish and carbon black while using a vacuum cleaner to remove dust arising at the same time.

Negative horn of arc chute

Remove the remaining contact material from the horn, which settles there during switching off.

Deionization plates

Immobilize loose deionization plates in left wall holes by fixing them again after previous projection upset or twist. Deionization plates must not touch each other and should be seated perpendicular to the plane of the wall. Replace the burnt deionization plates with new ones.

Arc chute release for operation.

Make sure that the arc chute, after screwing, is seated correctly in the insulating tray of the circuit-breaker and that the flexible cable is connected in accordance with the drawing placed on the arc chute. Carry out a voltage test on the circuit-breaker with 5 kV, 50 Hz, 1 min voltage.

13.3. MAINTENANCE OF ARC CHUTES: KBD-3/50b, KBDk-3/50b, KBDp-3/50b, KBDd-3/50b

Arc chute inspection.

Arc chute inspection must be carried out at least once a year. If no considerable signs of arc chute wear (such as: "pearling", sootiness at internal sides of the walls, loosening of deionization plates, loose or missing insulating plates) are found, then the arc chute operation can be continued. If considerable signs of wear occur, disassemble the arc chute, evaluate its condition and, if necessary, regenerate it.

After each repeated switching off occurring as a result of several hard short-circuits in short (few seconds) time intervals, arc chute inspection is suggested and, if necessary, it should be disassembled to evaluate its wear condition.

Arc chute wear condition evaluation and regeneration.

Arc chute insulating middle plate, right and left walls

Clean the surfaces of the insulation middle plate and the right and left walls with a scraper to remove "pearling", copper tarnish and carbon black while using a vacuum cleaner to remove dust arising at the same time.

Deionization plates and insulating plates

Immobilize loose deionization plates in right and left wall holes by fixing them again after previous projection upset or twist. Deionization plates must not touch each other and should be seated perpendicular to the plane of the wall. Secure loosened insulating plates in the deionization plates by crimping in a "trident". Complete missing insulating plates and replace the burnt insulating plates with new ones.

Right horn, internal horn and right horn

Remove the remaining contact material from the horn, which settles there during switching off.

Left beam, right beam

Clean the beams of contact material tarnish and carbon black and remove the dust.

Arc chute release for operation.

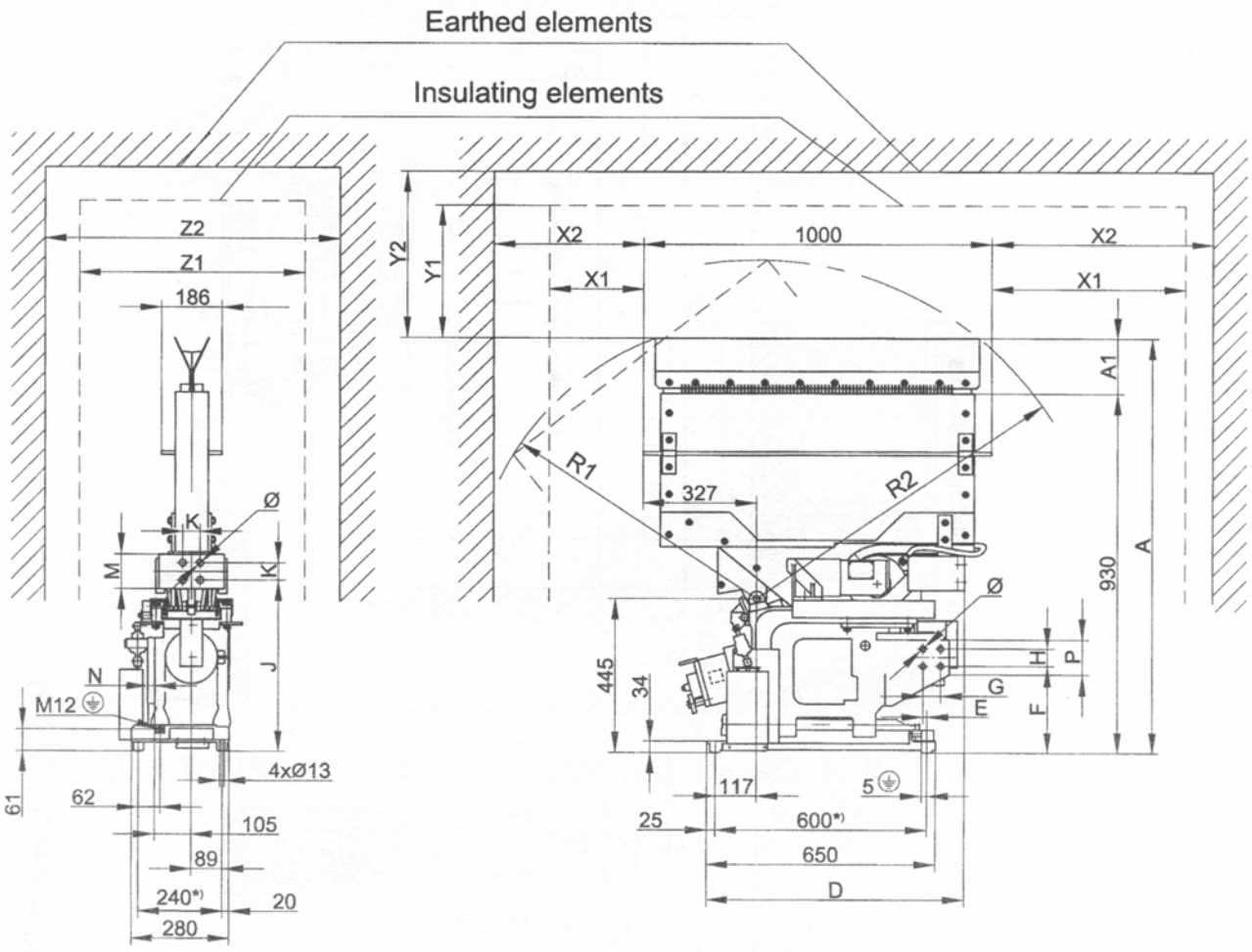
Make sure that arc chute is seated correctly in the insulating tray of the circuit-breaker and flexible cables are connected in accordance with the drawing placed on the arc chute. Carry out a voltage test on the circuit-breaker with 10 kV, 50 Hz, 1 min voltage.

14. PACKAGING, TRANSPORT, STORAGE

Circuit-breakers and arc chutes are protected from moisture and mechanical damage in transport. Avoid sudden shocks and overturn of cases during transport.

Circuit-breakers should be stored in closed spaces, that are dry, free of dust and chemically active vapours and gases.

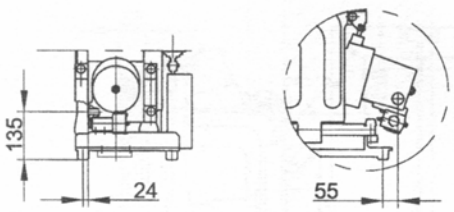
When lifting, use the circuit-breaker handles /40/ and arc chute axis /32/ as in fig.18. Be careful not to damage circuit-breaker components, in particular the insulating trays. Circuit-breakers must not be exposed to mechanical shocks during transport and storage. The surfaces of the keeper /7/ and the core /17/ are protected with vaseline for transport and storage.



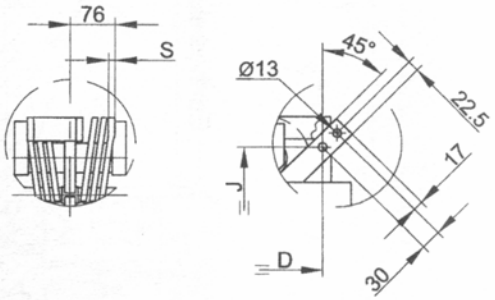
BWS circuit-breaker with arc chutes: KBD-3/50b, KBDk-3/50b, KBDd-3/50b

⊕ terminal 1600 ÷ 3150A

*) spacing of circuit-breaker mounting holes



Version with electro-pneumatic closing mechanism



⊕ terminal 630 and 1000A

Fig. 1. BWS circuit-breaker with arc chutes: KBD-3/50b, KBDk-3/50b, KBDd-3/50b.

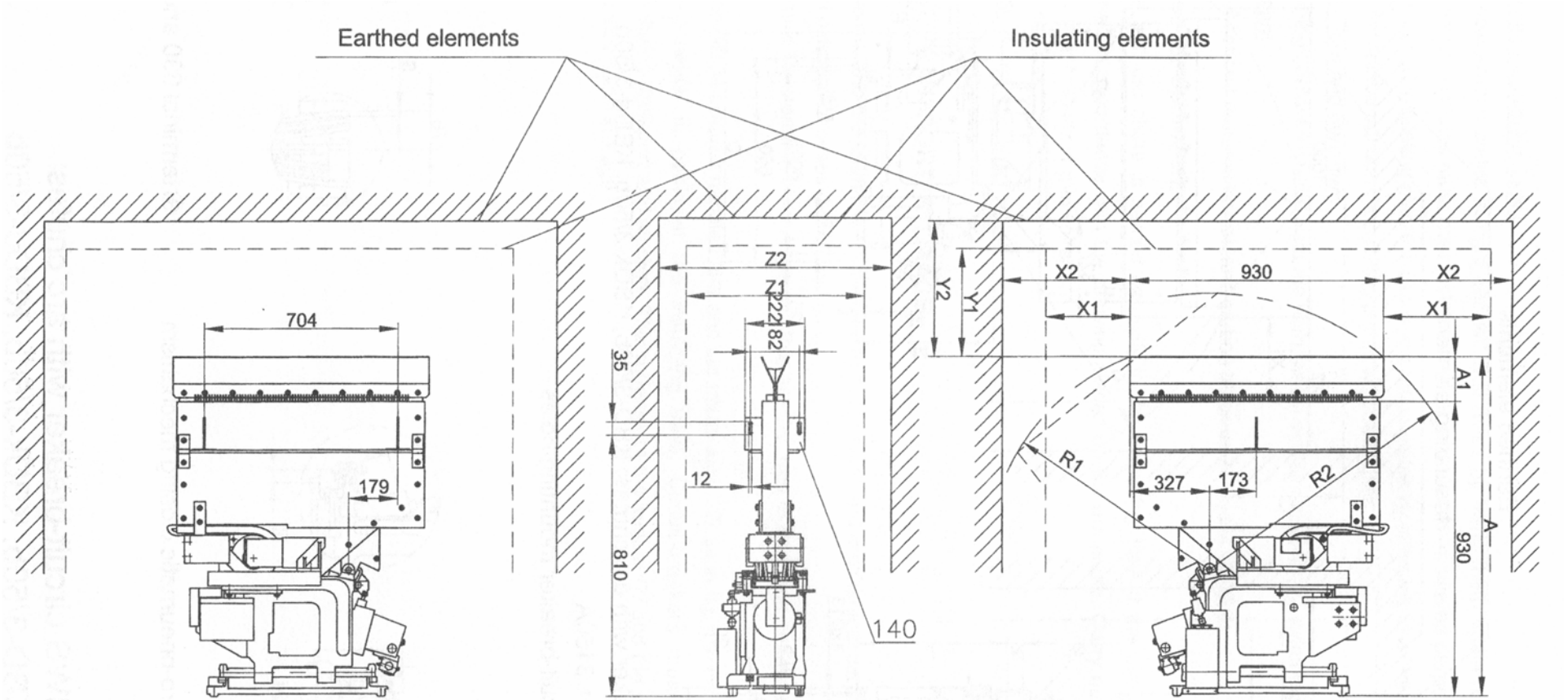


Fig. 2. BWS circuit-breaker with arc chute KBDp-3/50b.

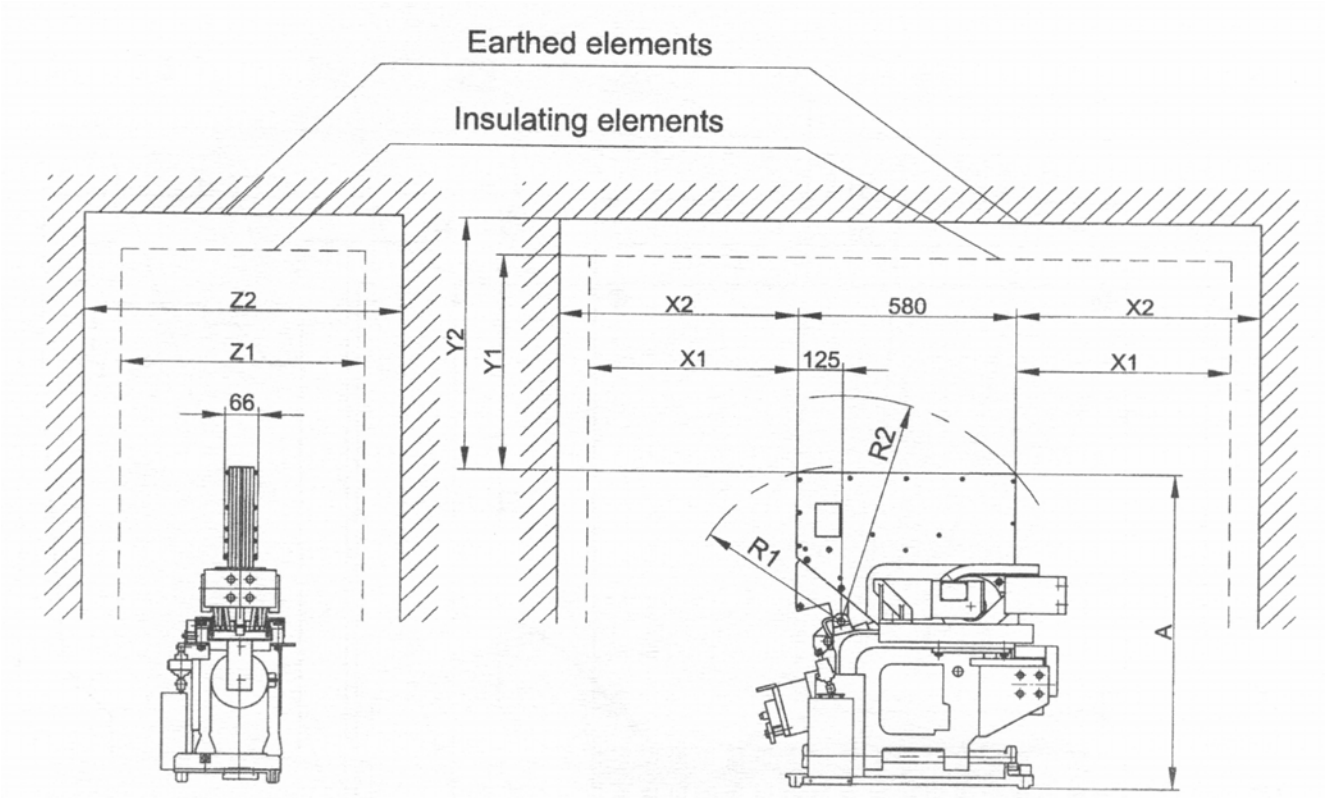


Fig. 3. BWS circuit-breaker with arc chutes: KBS-0,6; KBS-0,8.

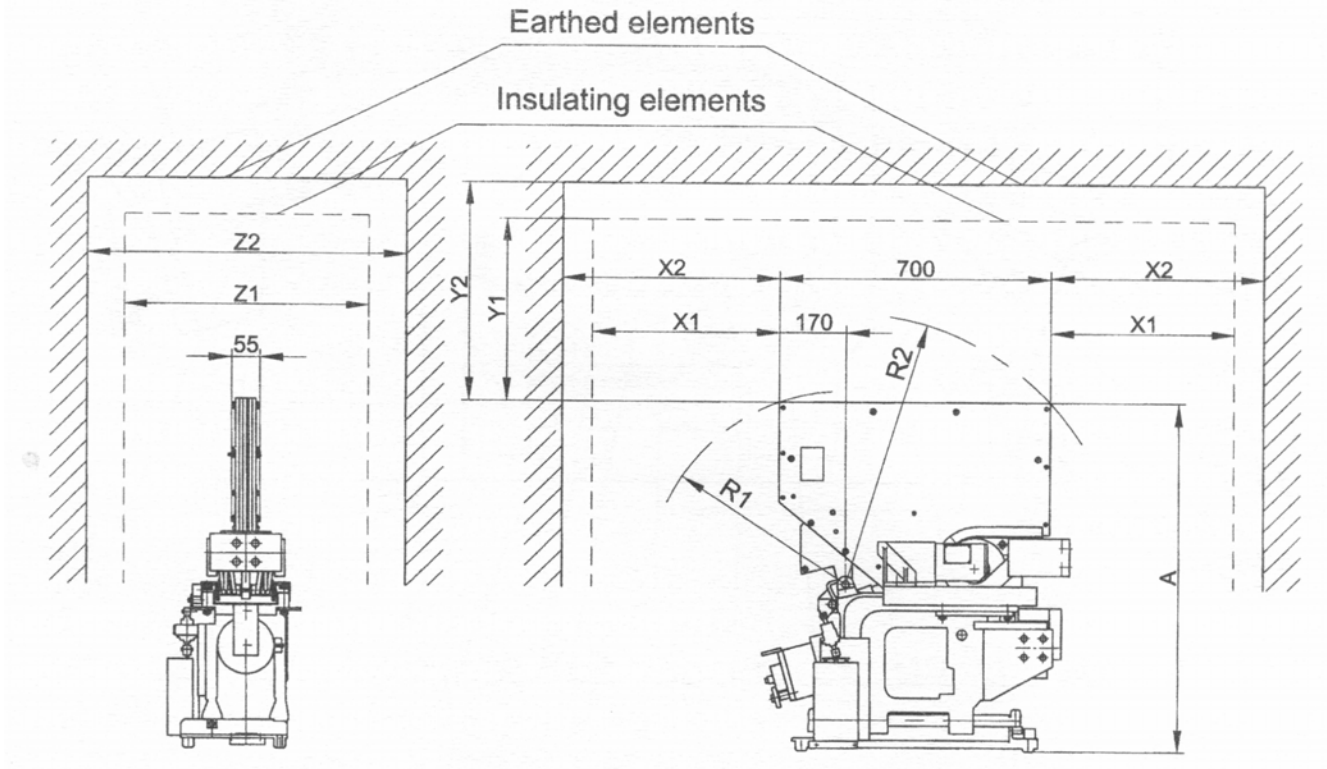


Fig. 4. BWS circuit-breaker with arc chute KBD-1,5.

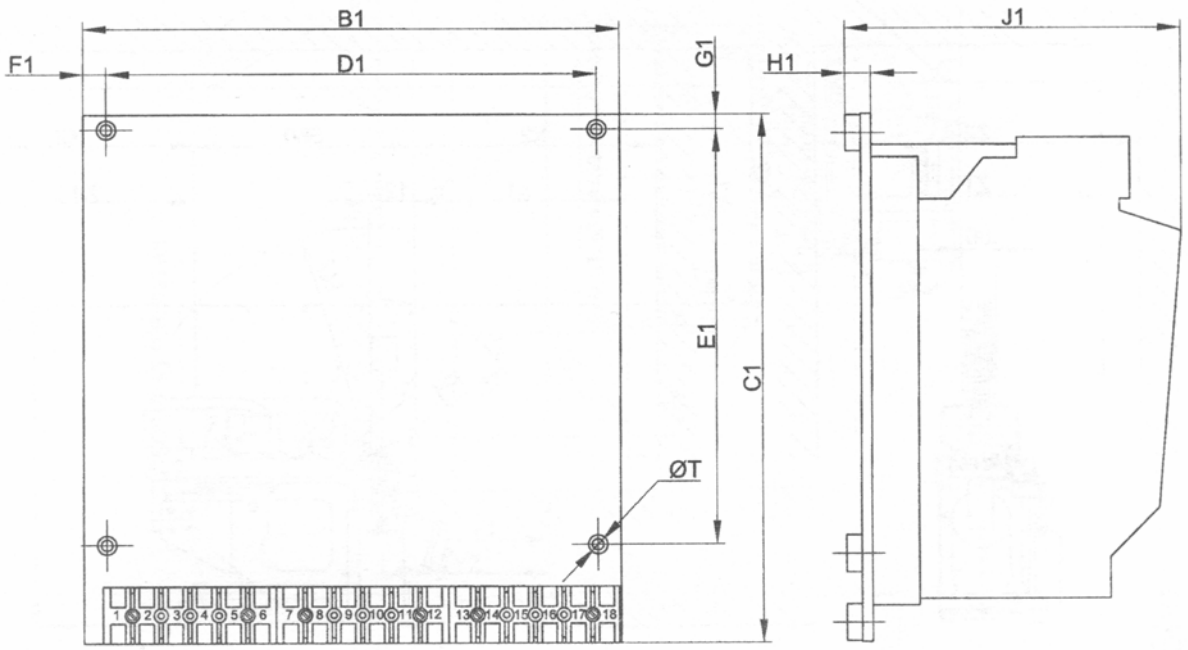


Fig. 5. Overall dimensions of control boards.

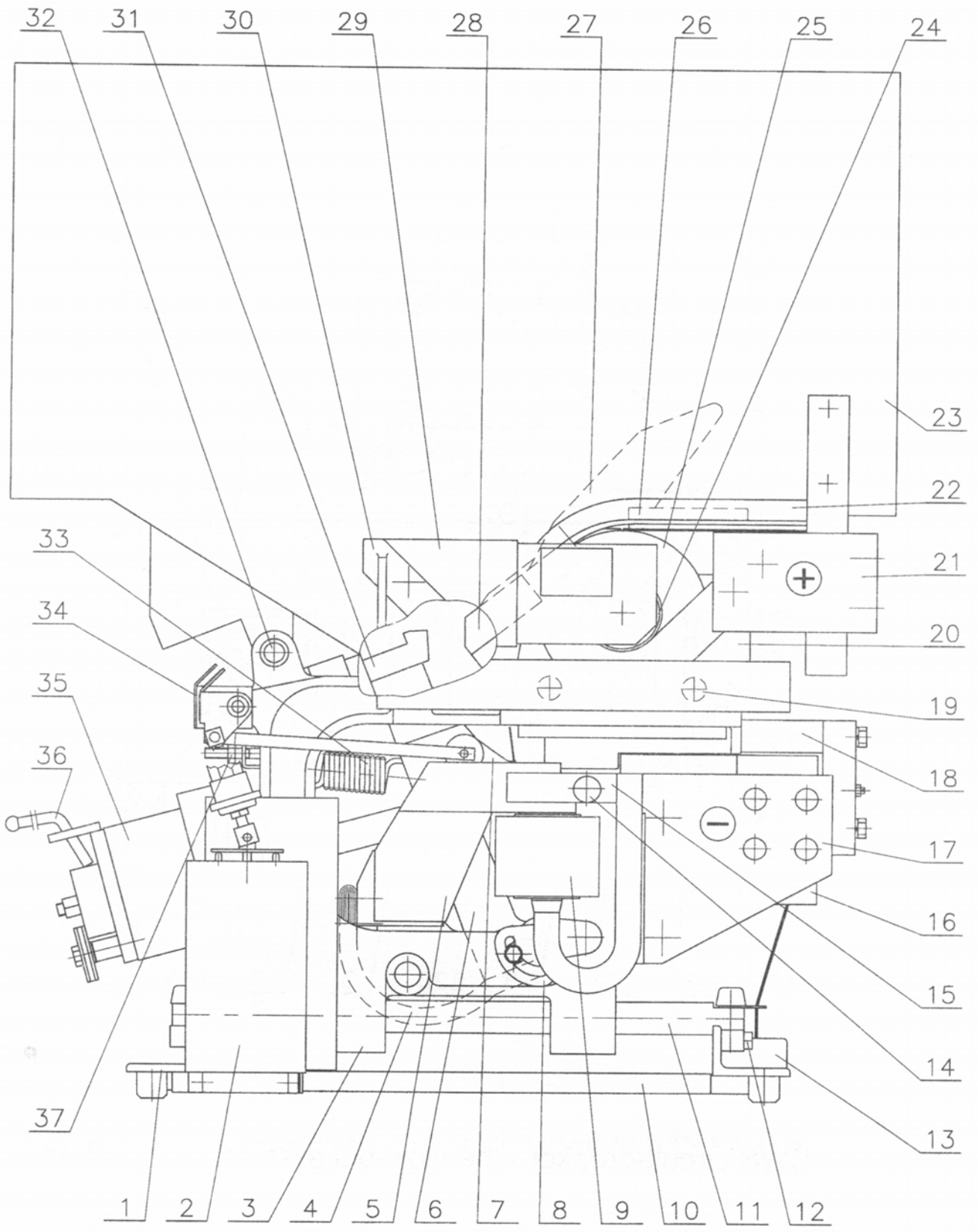


Fig. 6. BWS circuit-breaker - general view.

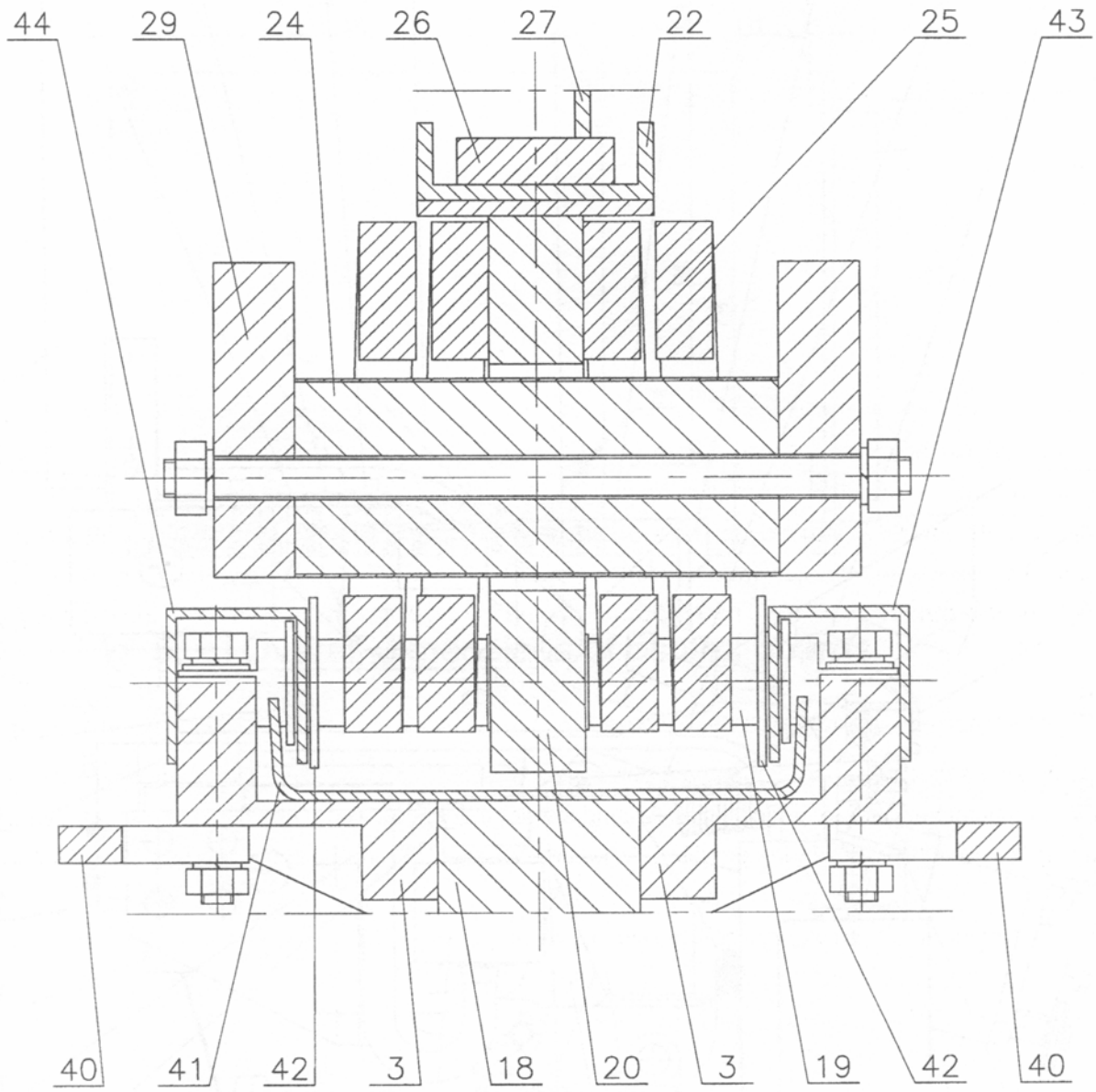


Fig. 7. BWS circuit-breaker - the blow-out system.

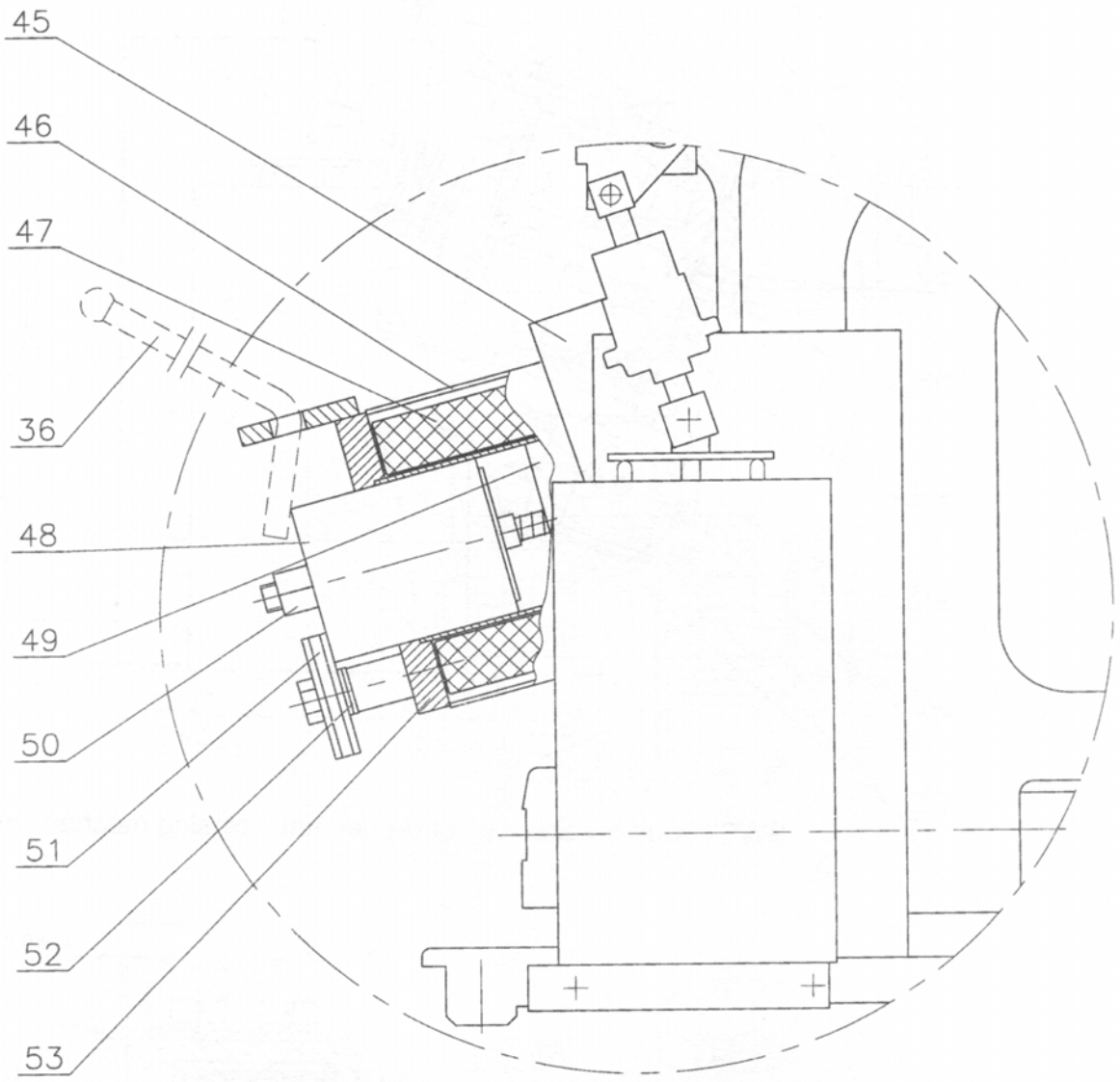
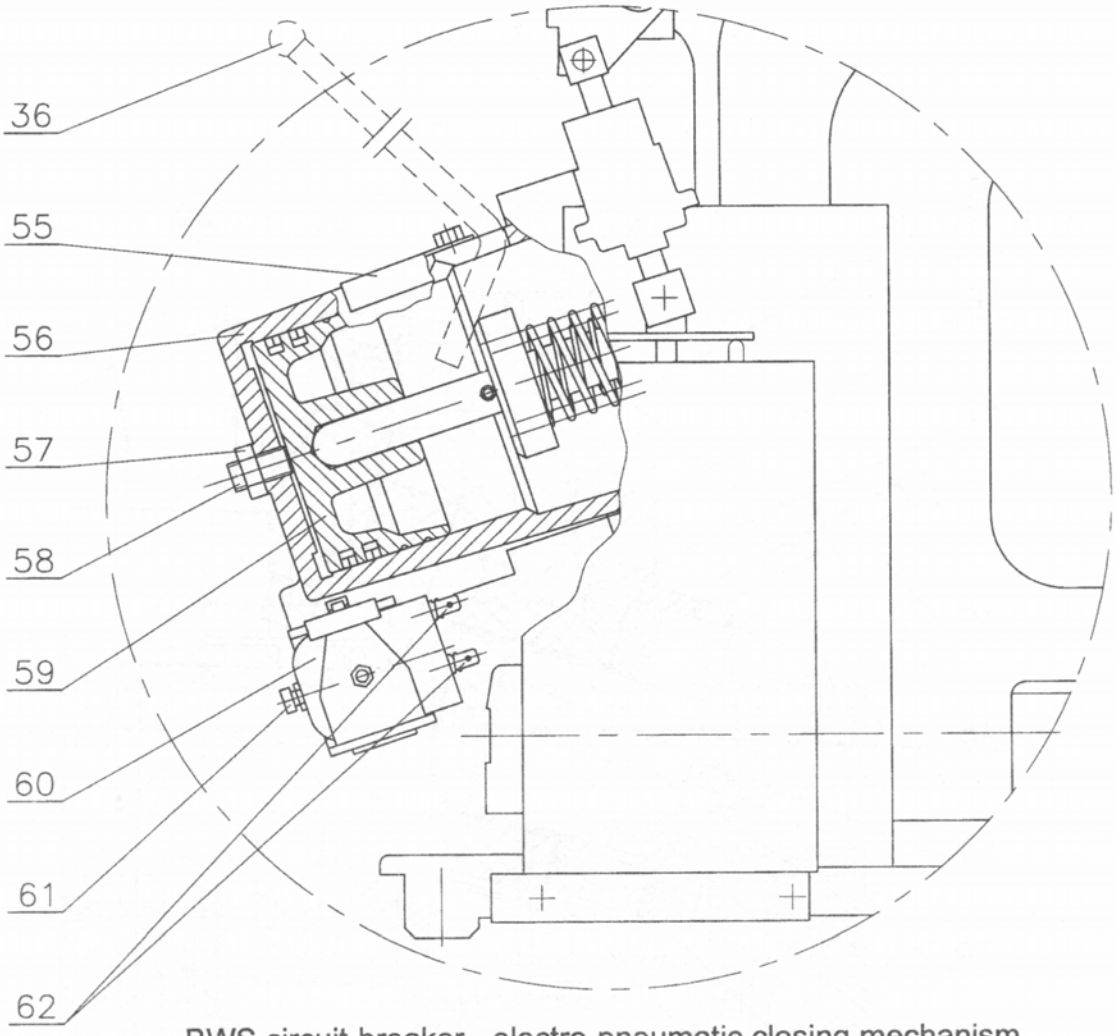
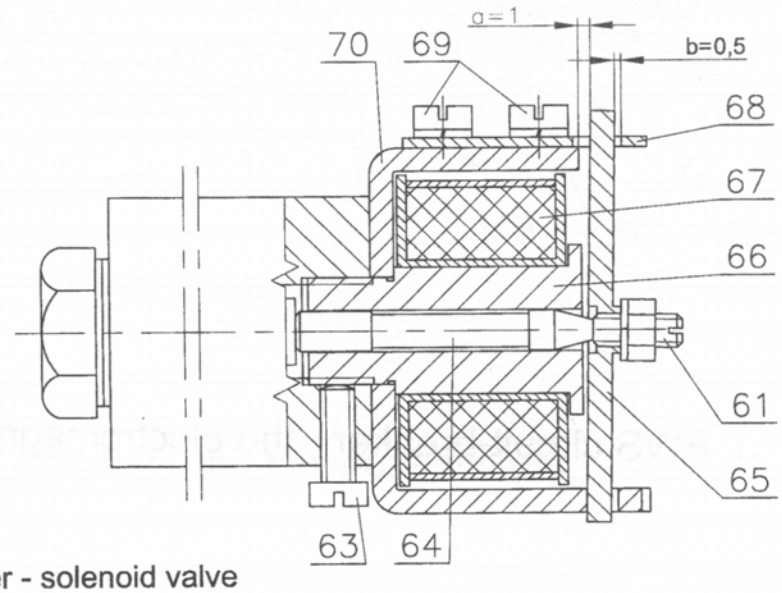


Fig. 8. BWS circuit-breaker - the electromagnetic closing mechanism.



BWS circuit-breaker - electro-pneumatic closing mechanism.



BWS circuit-breaker - solenoid valve

Fig. 9. BWS circuit-breaker - electro-pneumatic closing mechanism.

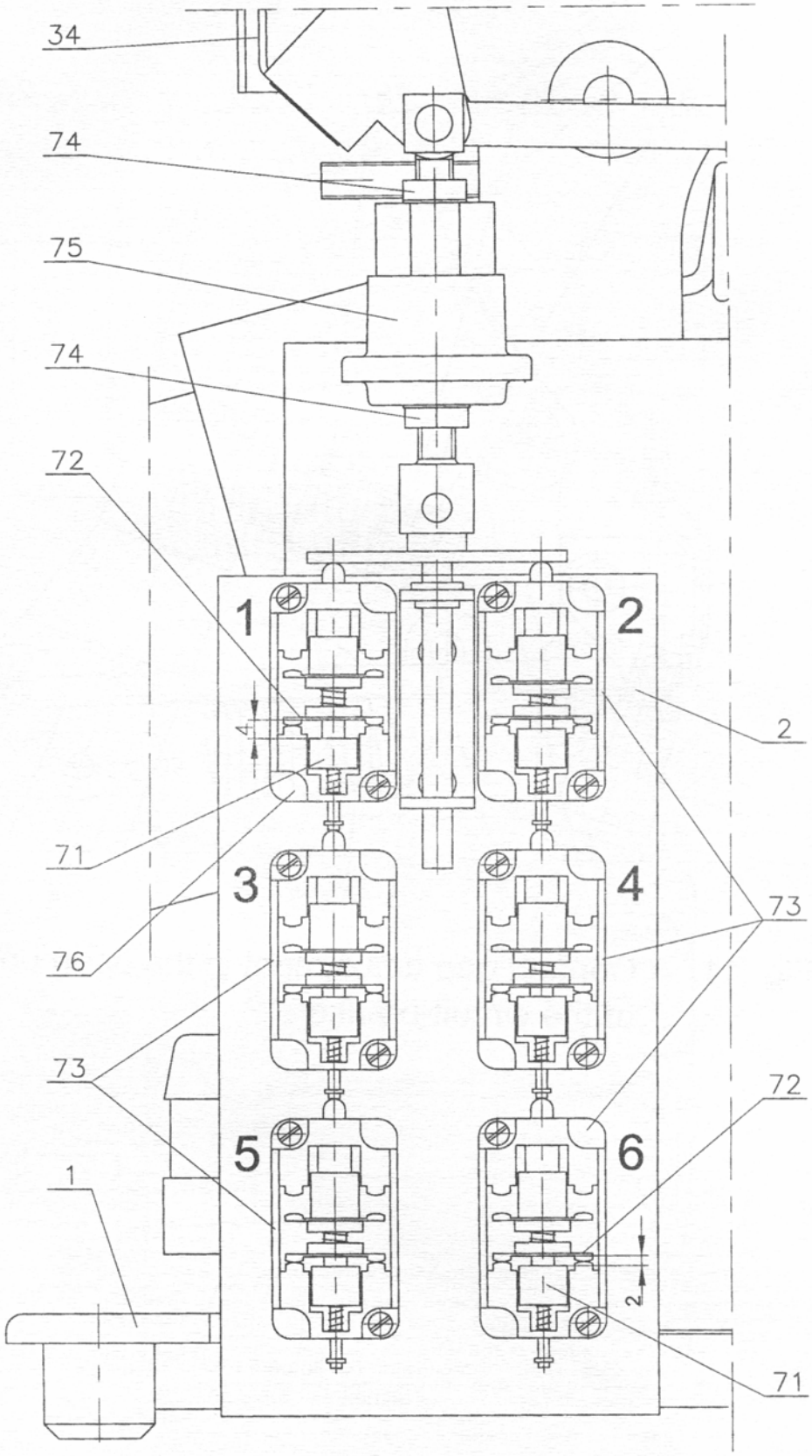


Fig. 10. BWS circuit-breaker - adjustment of auxiliary switches.

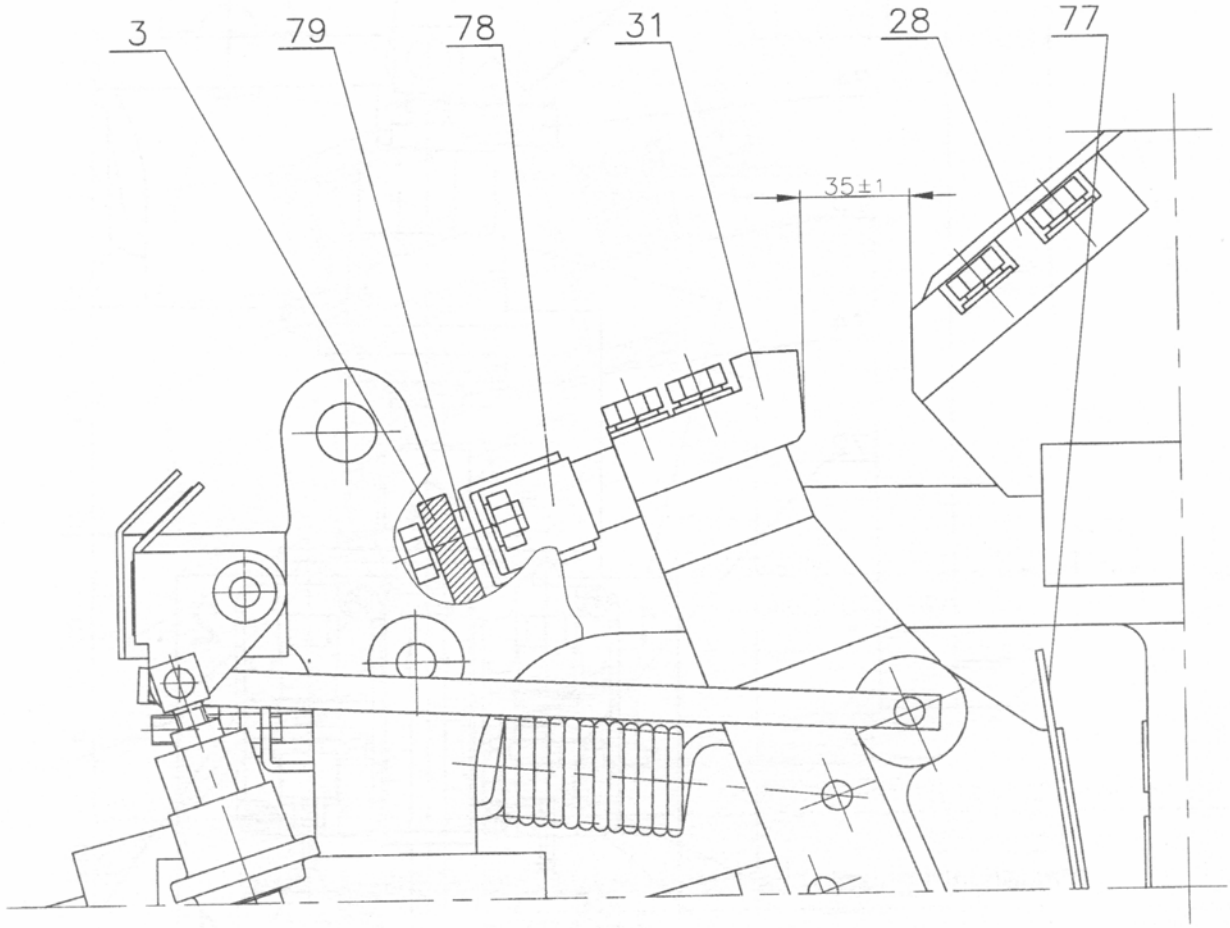


Fig. 11. Contact gap adjustment in the open position of the circuit-breaker.

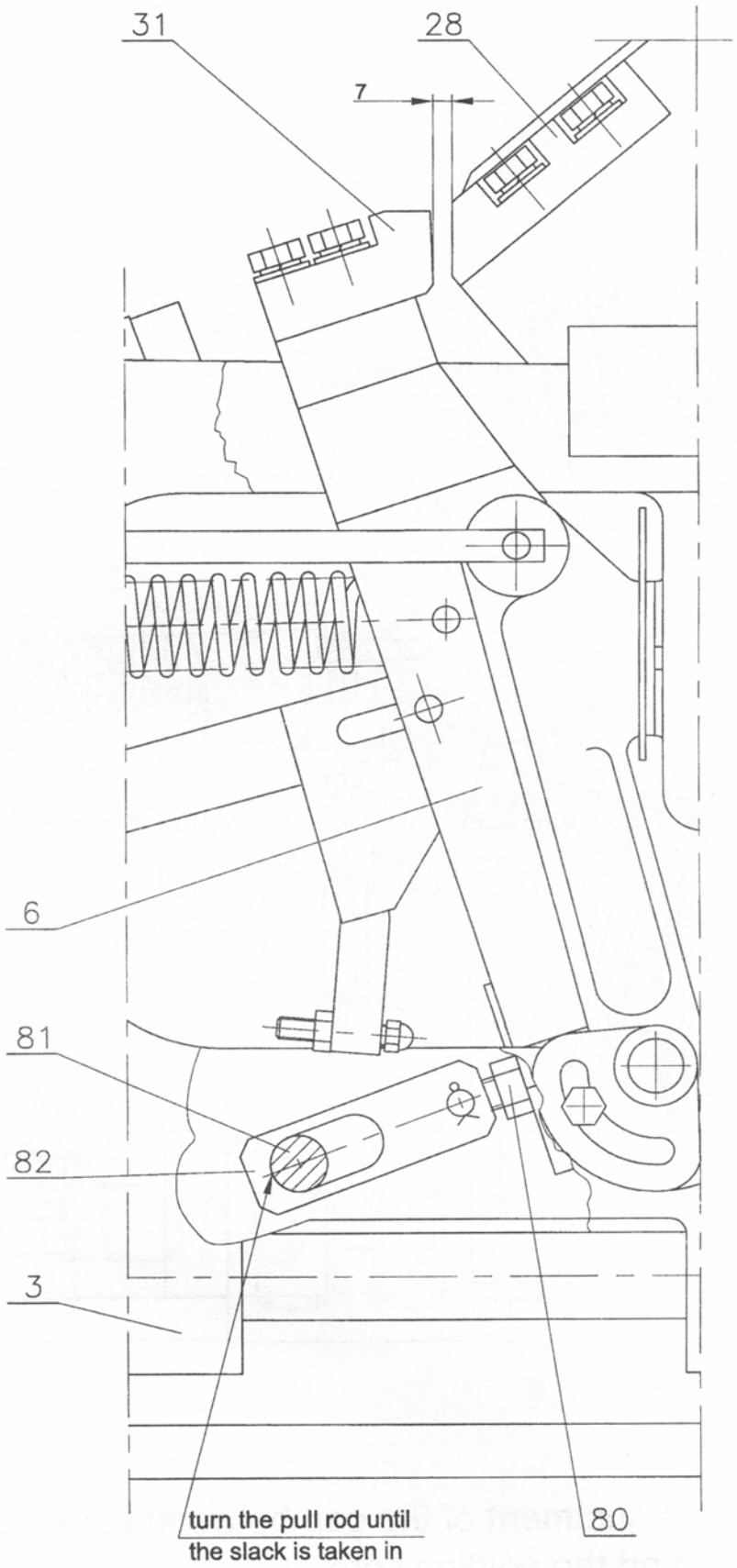


Fig. 12. Contact gap adjustment in transient condition.

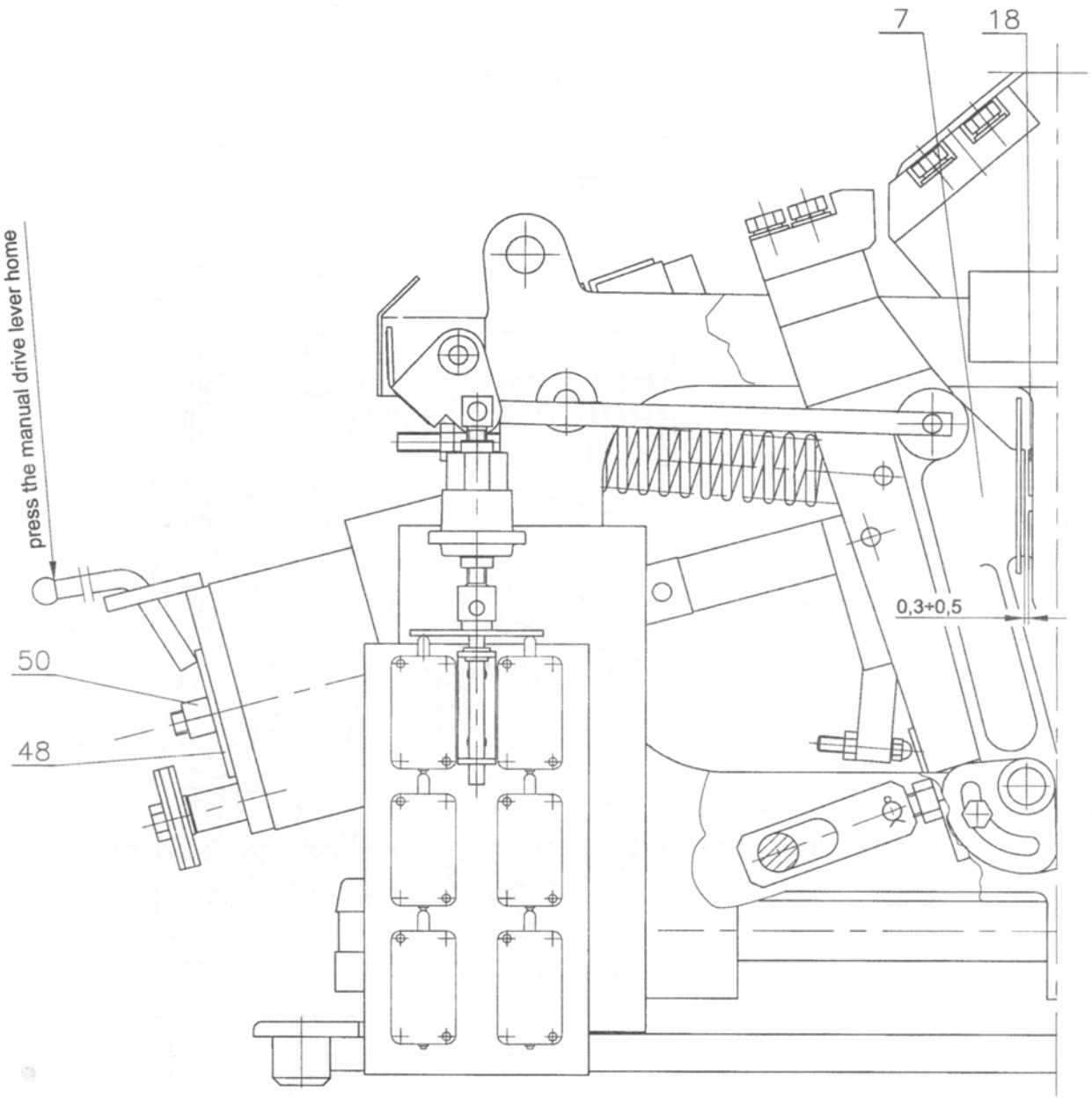


Fig. 13. Adjustment of the gap between the keeper and the holding core.

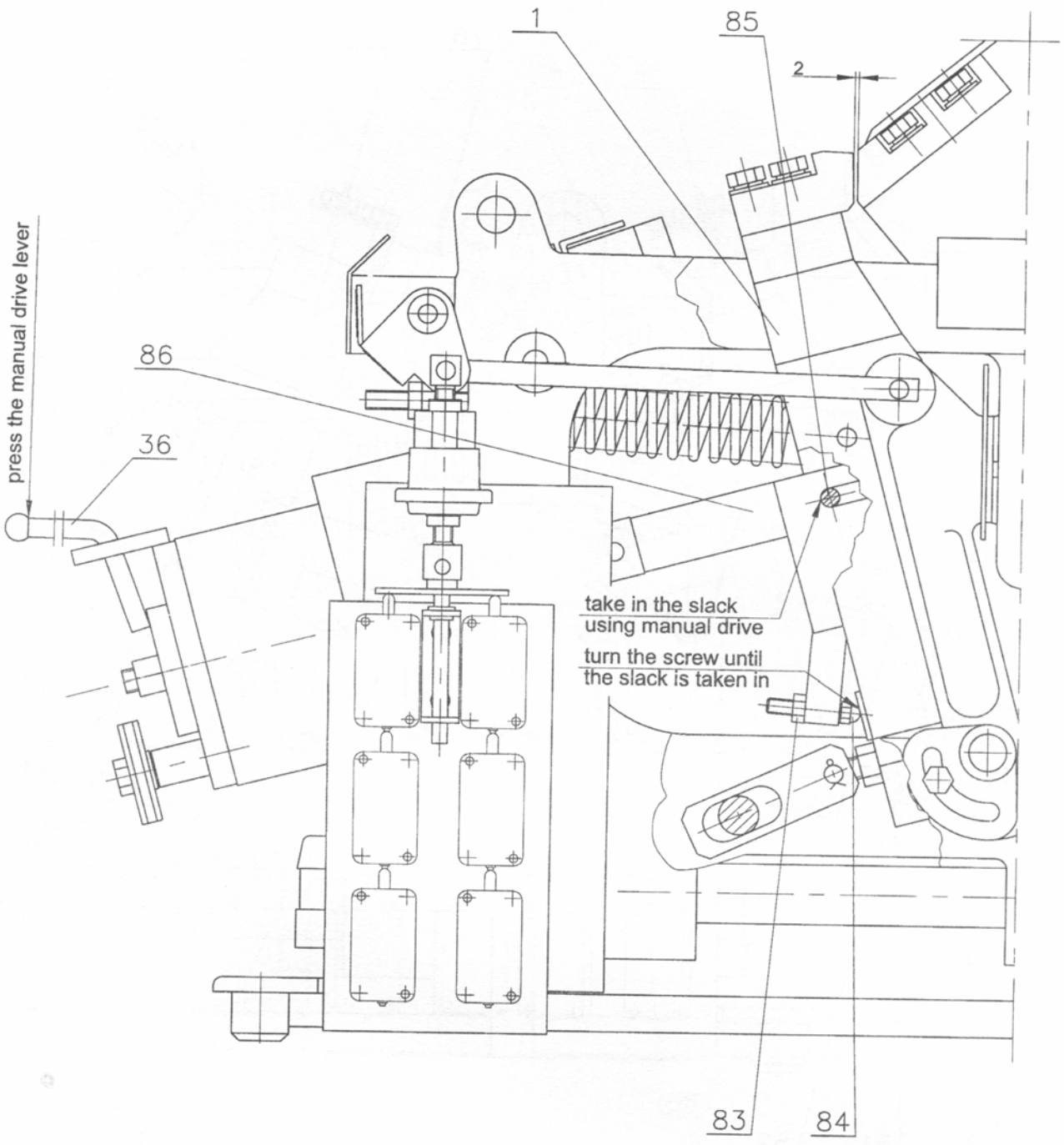


Fig. 14. Lower fulcrum adjustment for the moving contact arm.

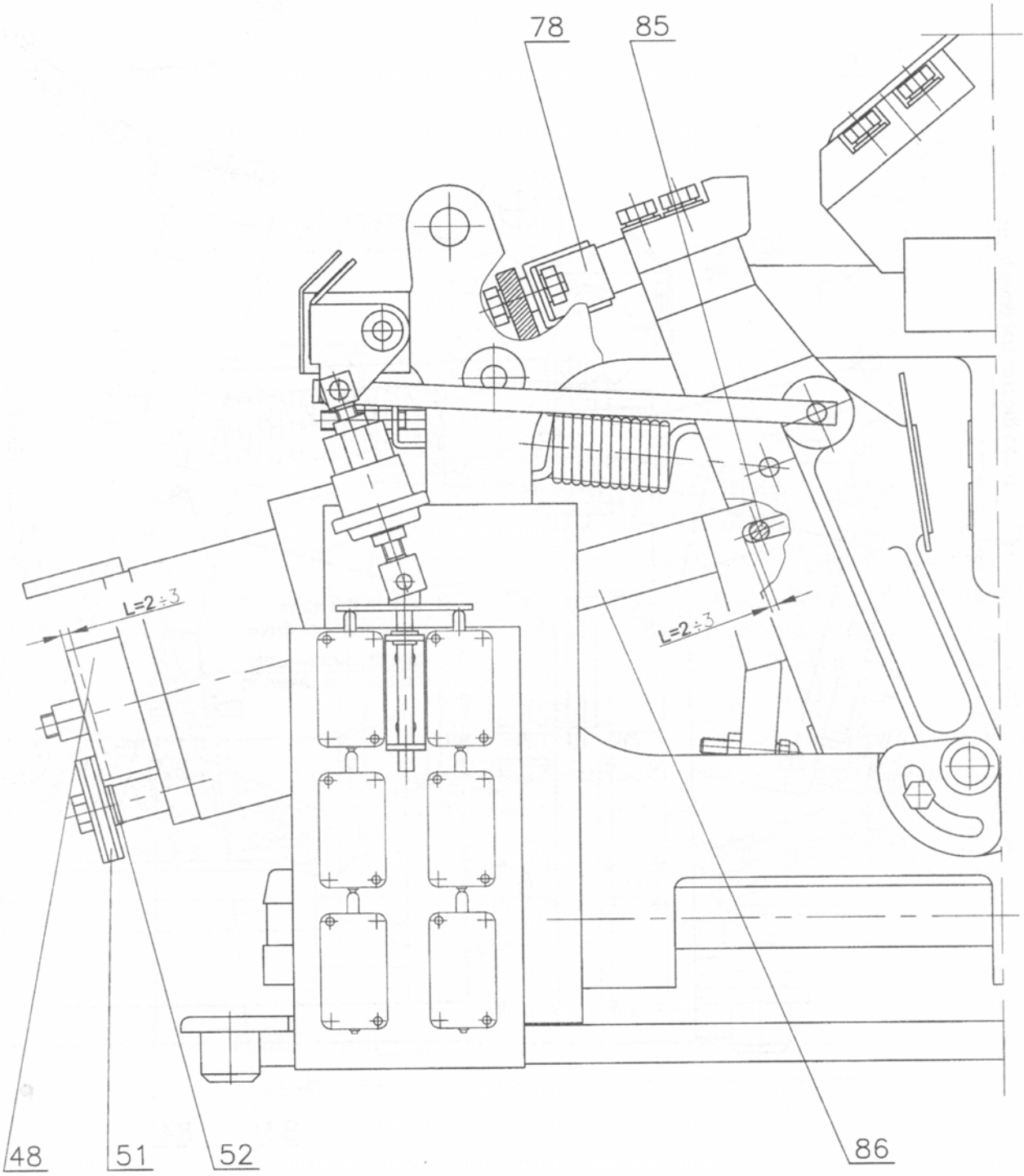


Fig. 15. Adjustment the initial plunger position.

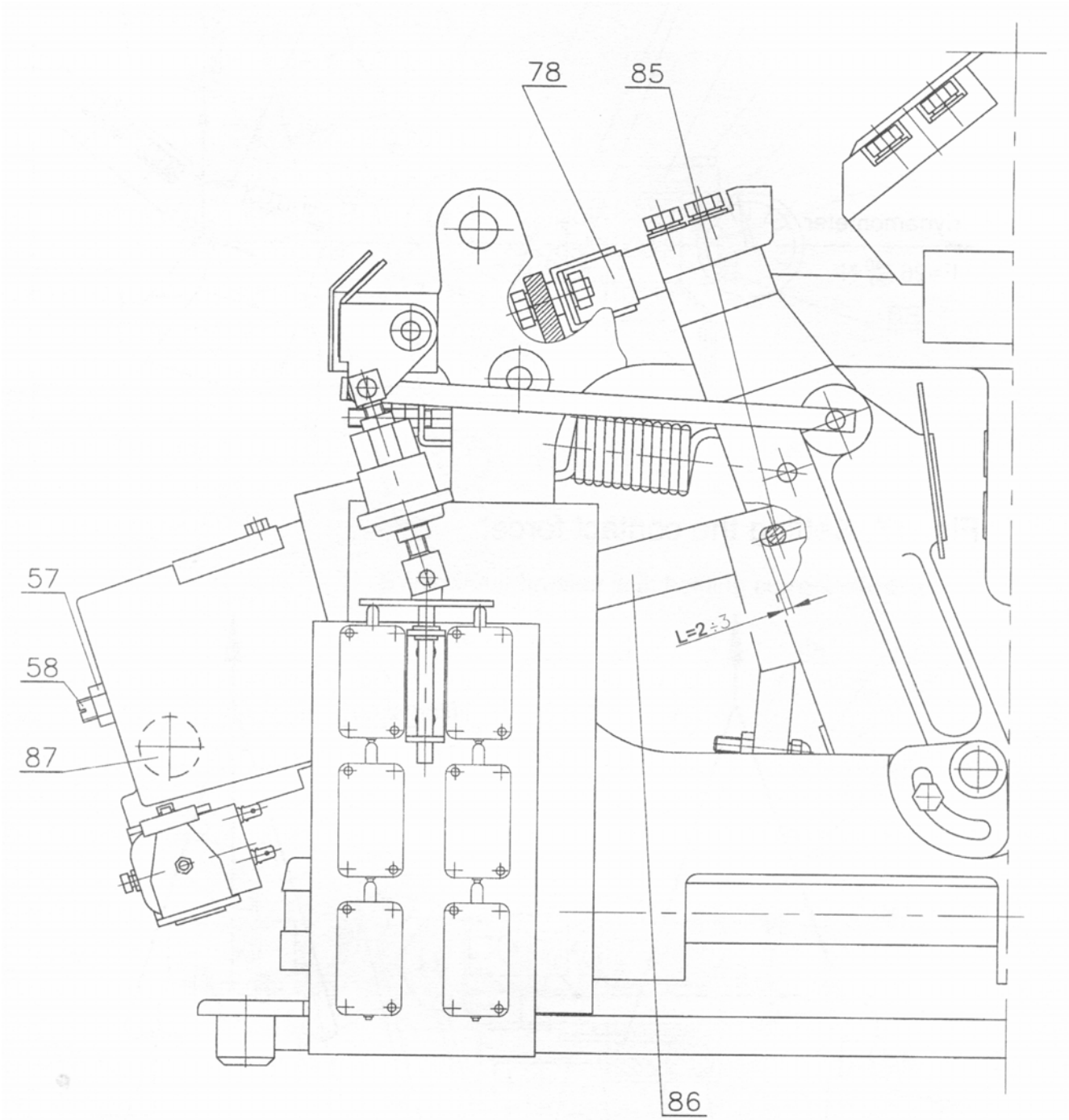


Fig. 16. Adjustment the initial piston position.

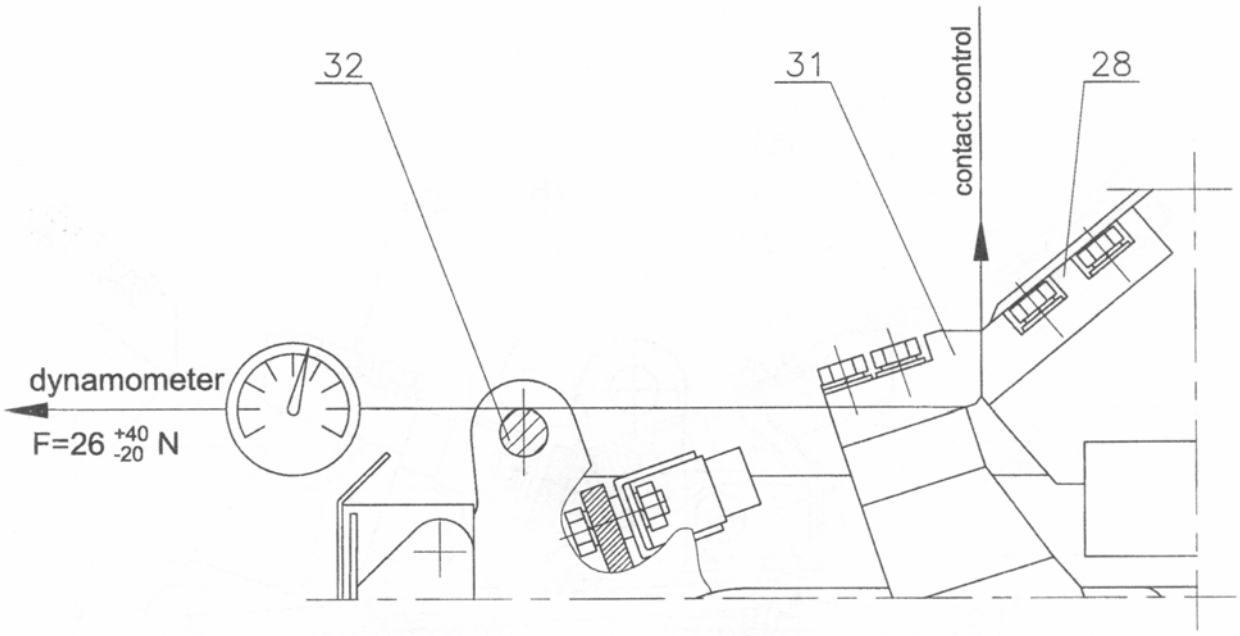


Fig. 17. Setting the contact force.

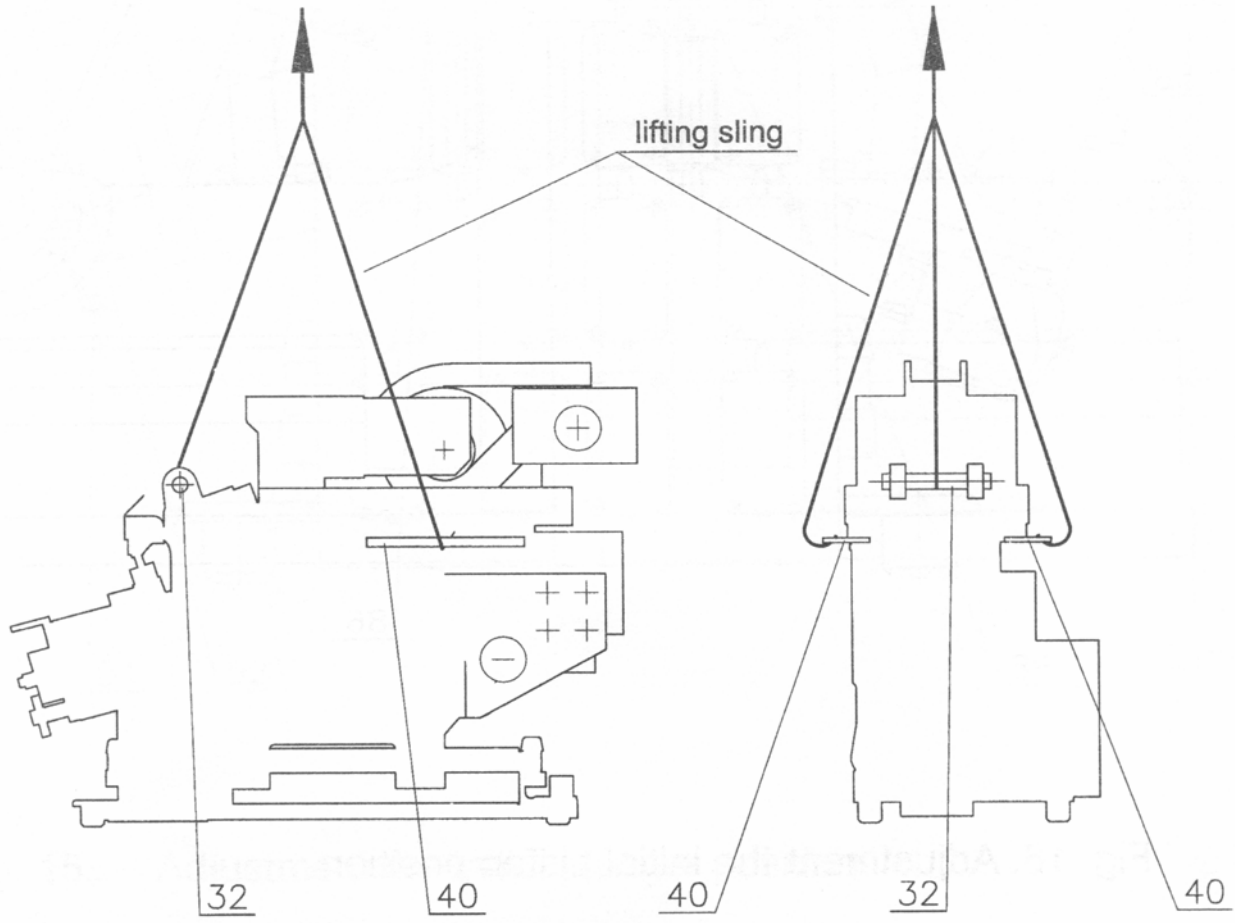
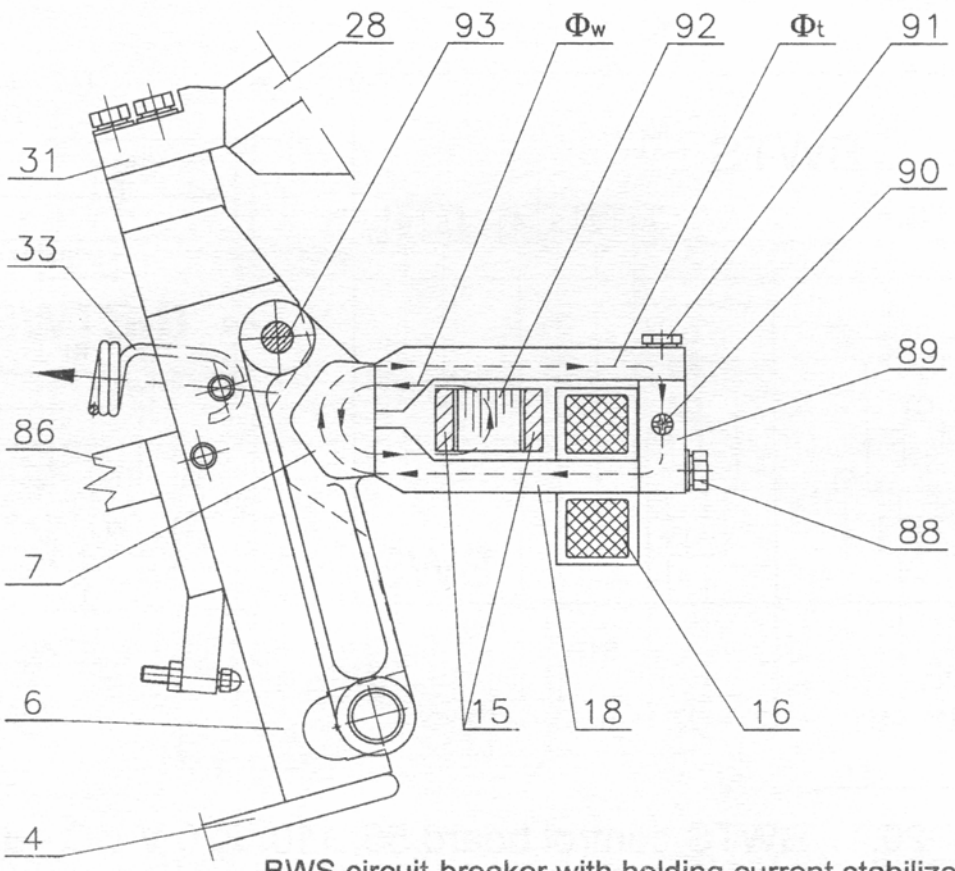
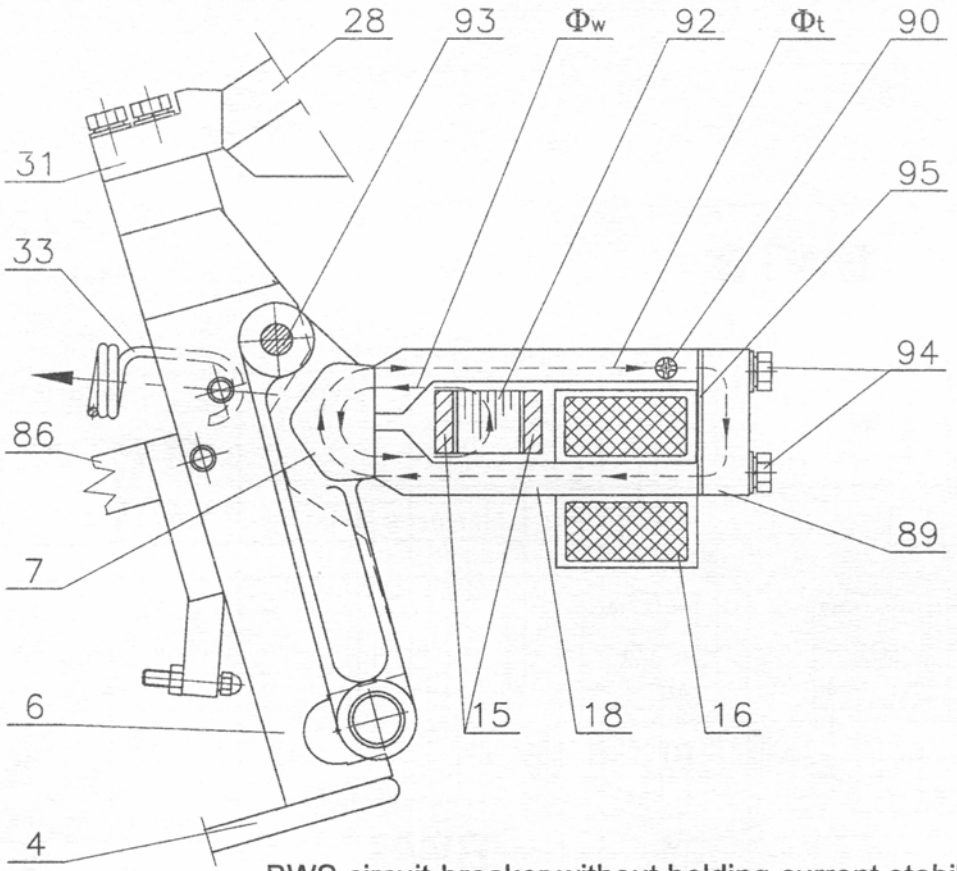


Fig. 18. Lifting of the BWS circuit-breaker.



BWS circuit-breaker with holding current stabilizer.



BWS circuit-breaker without holding current stabilizer.

Fig. 19. Keeper magnetic circuit.

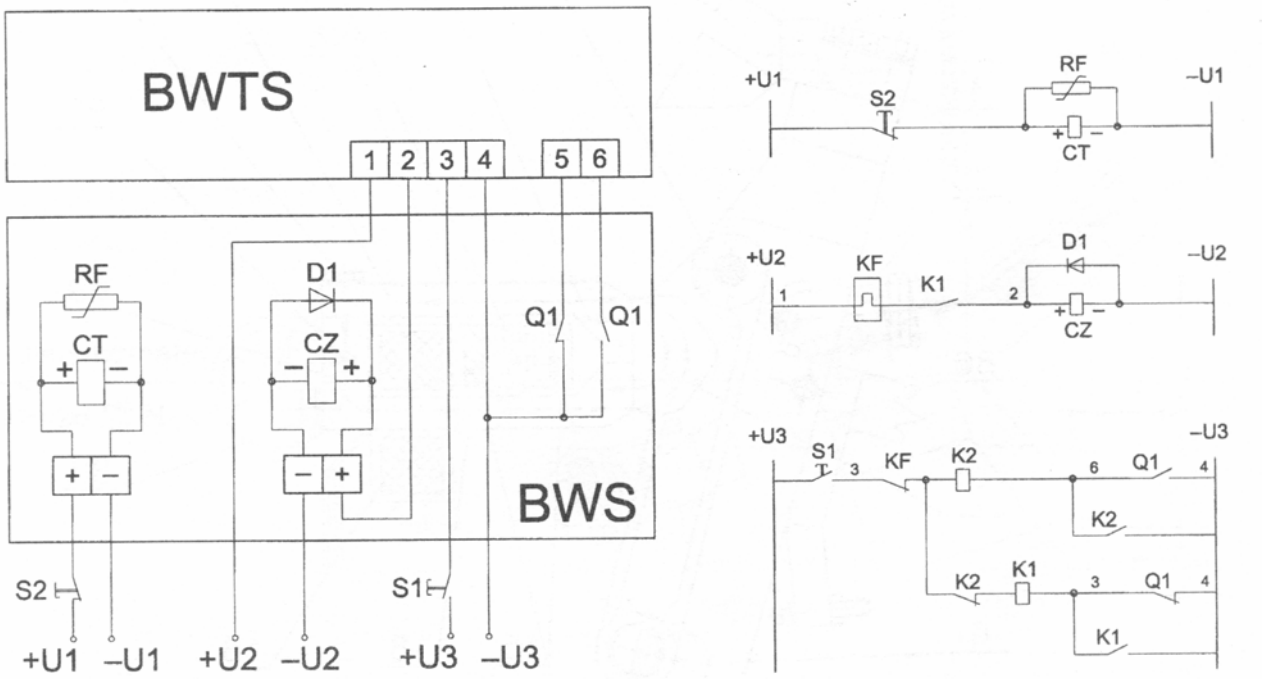


Fig. 20. BWTS control board 55, 110, 220 V DC - diagram.

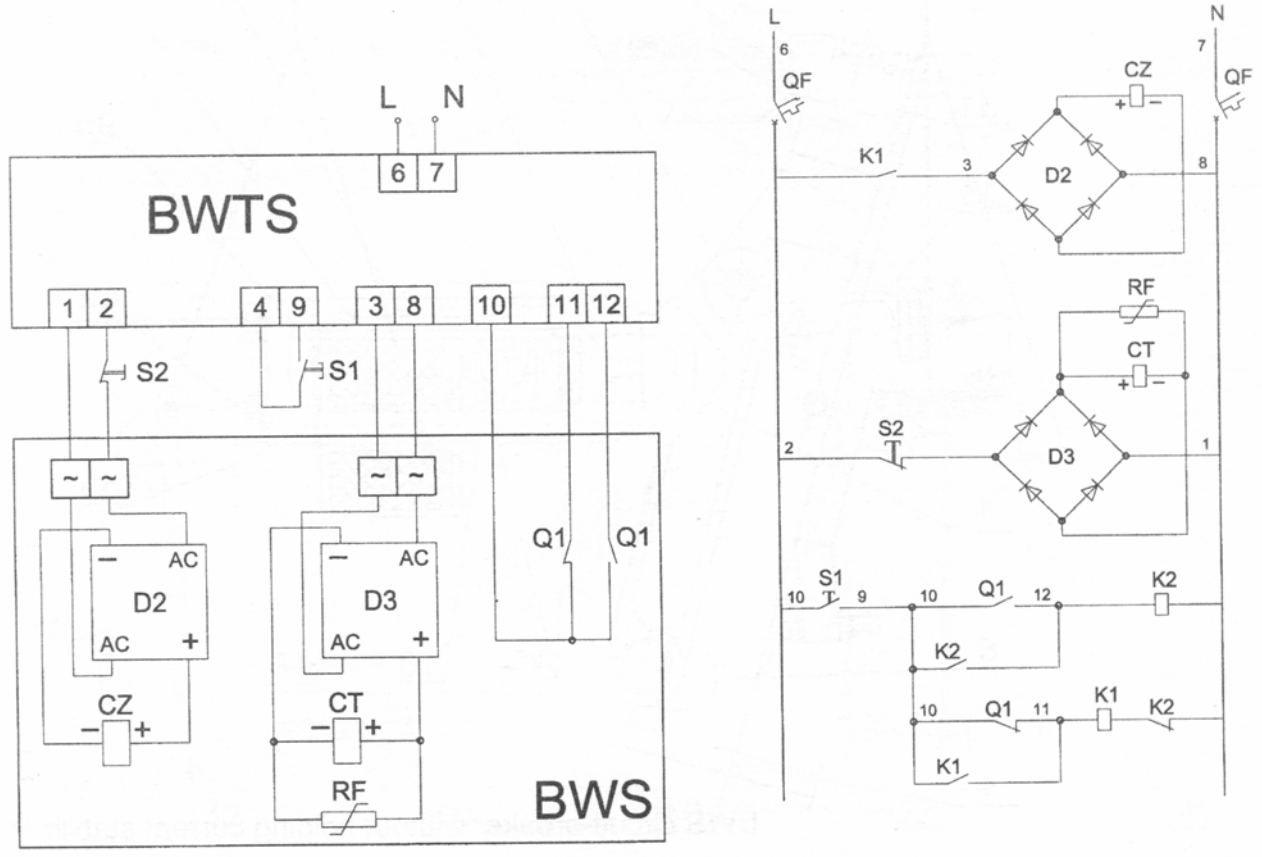


Fig. 21. BWTS control board 220 V AC - diagram.

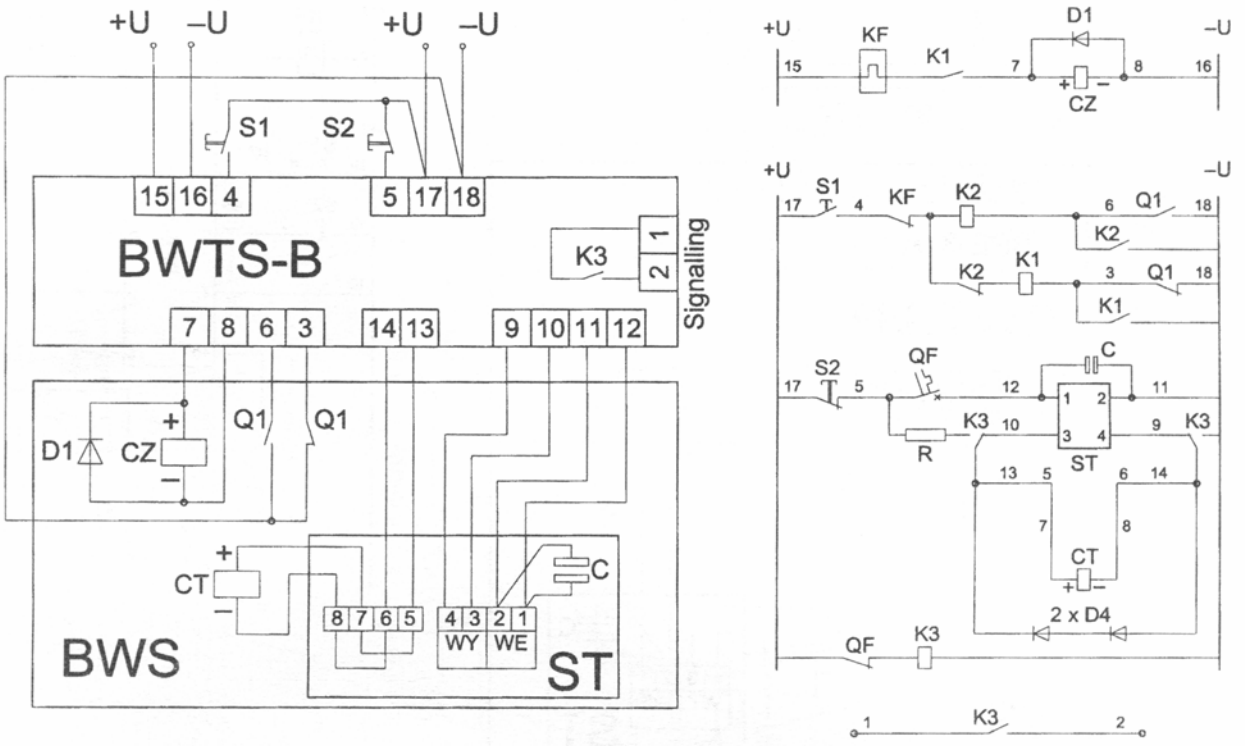


Fig. 22. BWTS-B control board 110, 220 V DC - diagram.

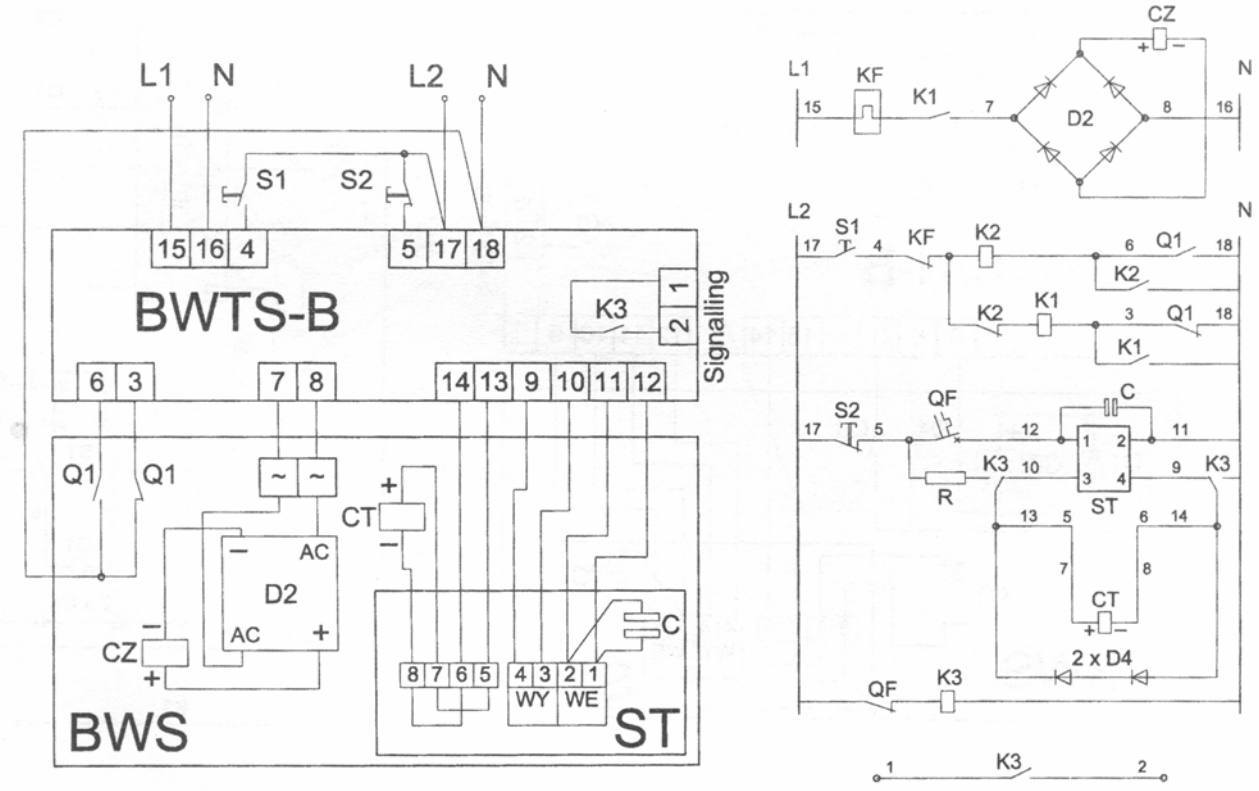


Fig. 23. BWTS-B control board 220 V AC - diagram.

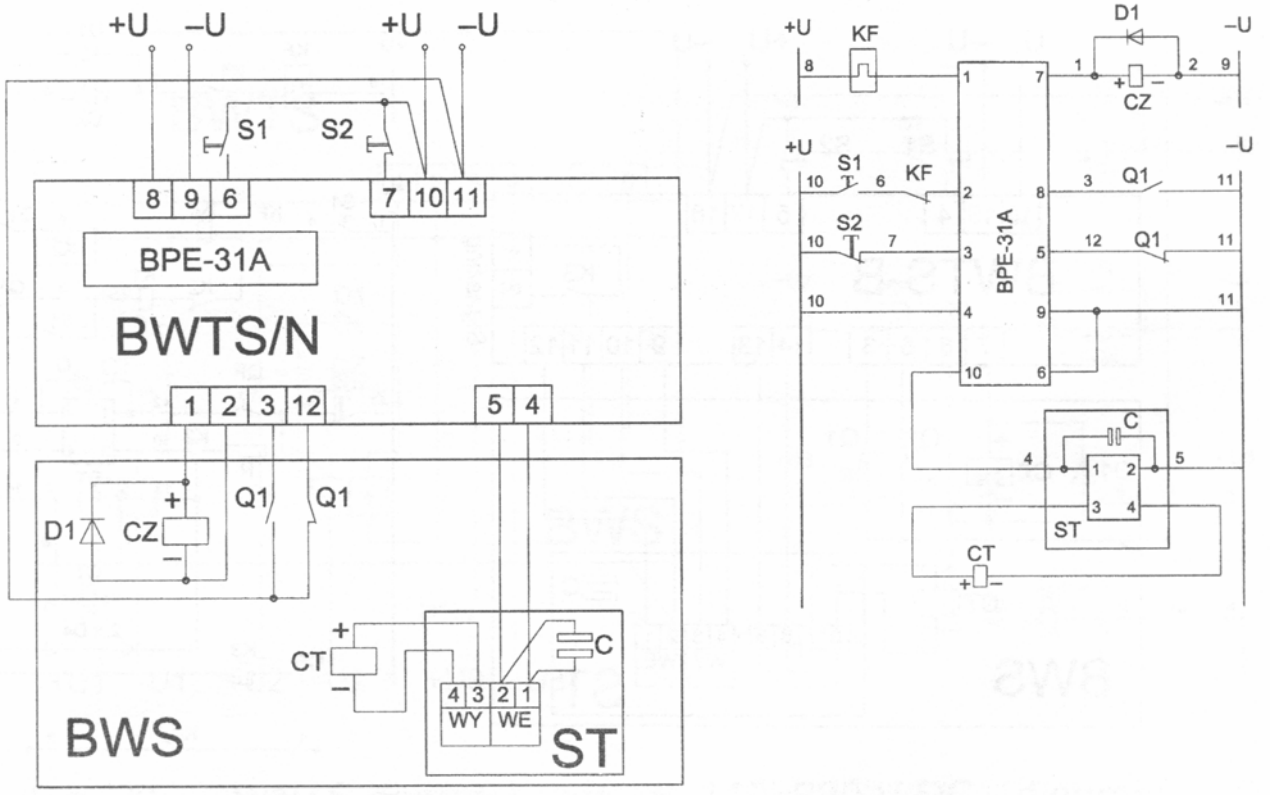


Fig. 24. BWTS/N control board 220 V DC - diagram.

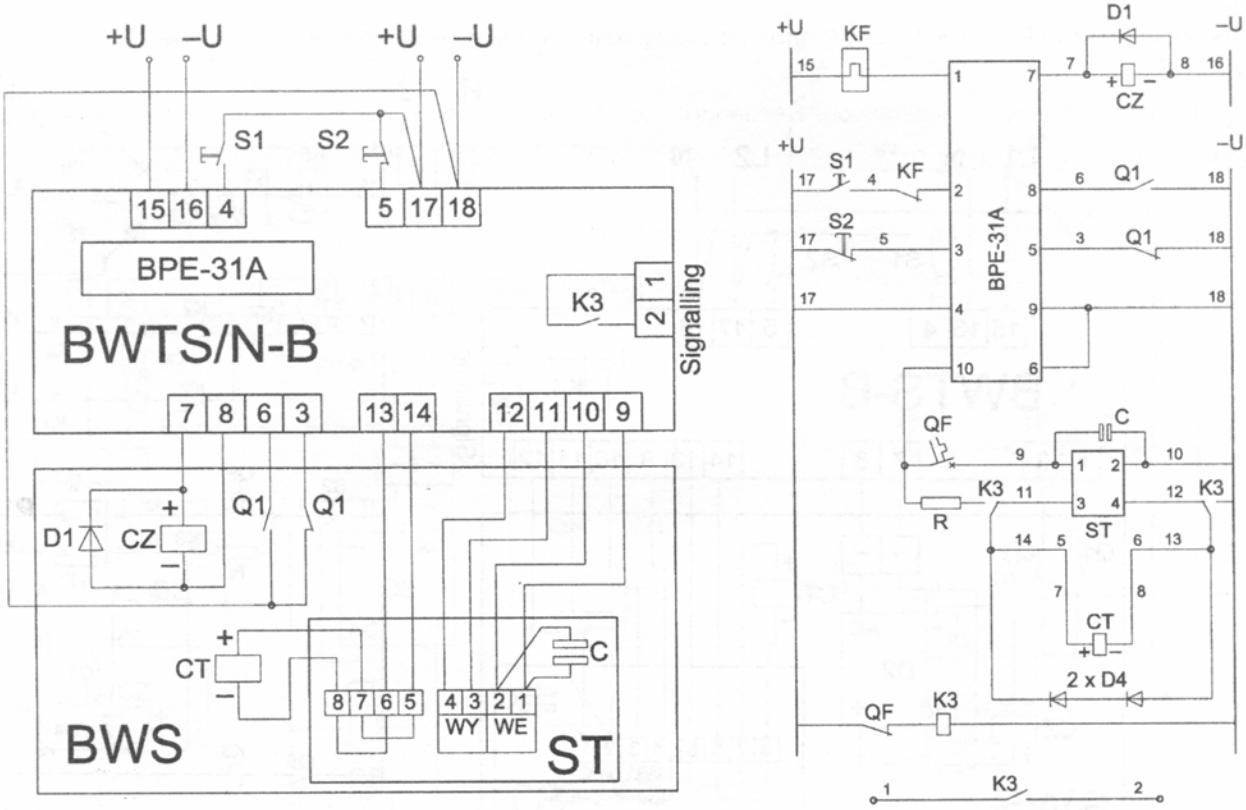


Fig. 25. BWTS/N-B control board 220 V DC - diagram.

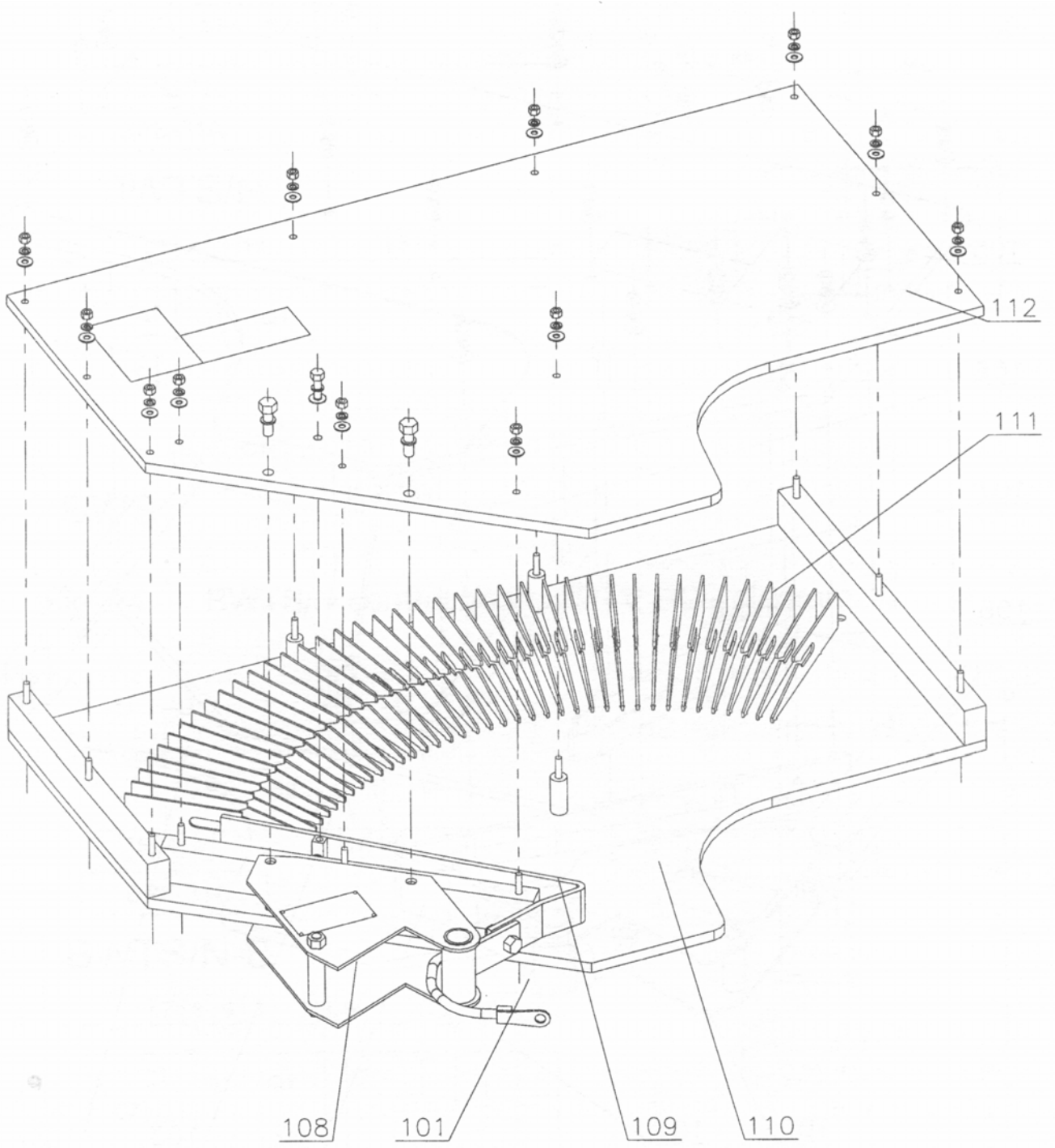


Fig. 27. KBD–1,5 Arc Chute.

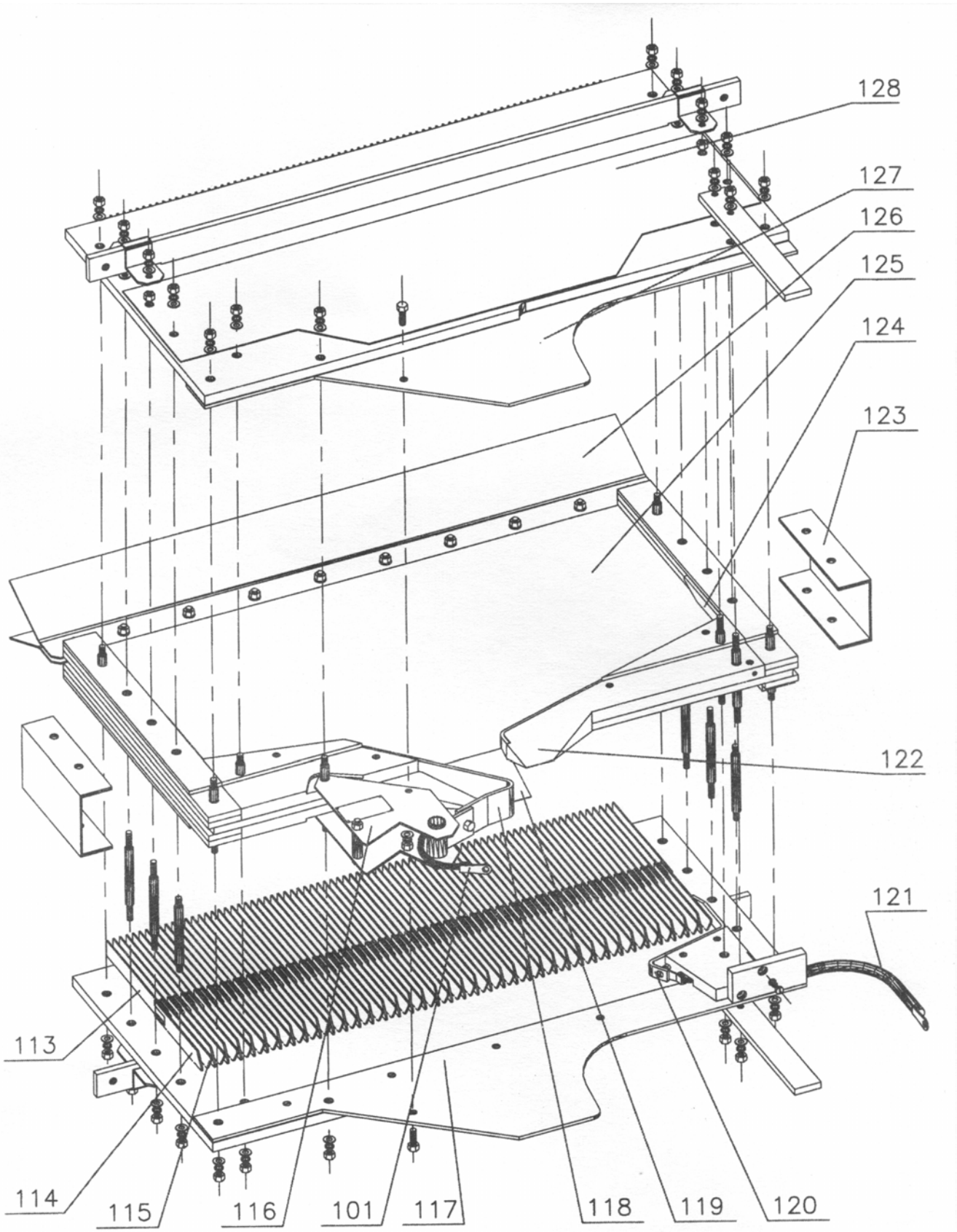


Fig. 28. KBD–3/50b Arc Chute.

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